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CONTENTS

EDITORIALS:
- Can You Write a Good Story? 627
- Why Your Copy Is Late 627
- Economy and the Test Department 627
- Injustice to Helpers and Apprentices 628
- Development of Shop Foremen 628
- Paint the Steel Cars 628
- Bearing Pressures on Tender Truck Journals 628
- What About the Valve Setter? 629
- Reinstating the Rules of Interchange 629
- New Books 629

COMMUNICATIONS:
- Inadequate Main Driving Boxes 630
- Thermit vs. Autogenous Welding 630

GENERAL:
- New Canadian Pacific Locomotives 631
- Shop Employees' Wage Agreement 637
- Simplex Oil Cup 642
- The Cost of British Locomotives 643
- Railroad Administration News 643
- Steel Fireboxes in European Locomotives 645
- Ripken Automatic Drifting Valve for Locomotives 645
- A Convenient Record for Air Brake Material 646

CAR DEPARTMENT:
- The Tank Car Maintenance Problem 647
- Car Inspectors and Foremen Meet 649
- U. S. R. A. Standard Caboose Car 654
- Suggestions for Improving Draft Gears Maintenance 656
- Maintenance of Freight Equipment 657

SHOP PRACTICE:
- Shop Practice at Transcona 661
- Liners for Driving Boxes and Pedestal Caps 662
- Steel Treaters' Society Convenes 663
- Setting Locomotive Valves 669
- Patching Piston Valve Cylinders 674
- The Casehardening of Steel 675

NEW DEVICES:
- A Back Geared Upright Power Drill 677
- Gravity Feed Band Saw 677
- The Wallace Bench Jointer 678
- Oliver Hand Planer and Jointer 678
- A Convertible Stock Car 679
- Forged-Cutter Tool Holder 680
- Collapsible Equalizing Piston for H-6 Automatic Brake Valve 680
- Detachable Air Drill 681
- Power Hammer Guard 681
- A Quick Operating Hose Coupling 682
- The Silver Radial Drill 682
- Hydrogen Gas for Cutting and Welding 683
- Lucas Headlight and Marker Lamps 683
- Column Clamping Device 684

GENERAL NEWS:
- Notes 685
- Meetings and Conventions 686
- Personal Mention 686
- Supply Trade Notes 688
- Catalogues 690

CAN YOU WRITE A GOOD STORY?

Does the romance in the day's work appeal to you?

Do you take a keen interest in the study of human nature?

From your personal experience have you a clear vision of some of the unsolved problems in the motive power or car departments? Better yet, have you some ideas of your own as to what might be done to improve supervision, put production on a better basis, or take the kinks out of the organization?

If you can answer "Yes" to these four questions, or even to the first three of them, would you like to give expression to your conception of the unsolved problems of the department, or to your ideas for their solution, in the form of a story with the shop, roundhouse, repair yard or office as the scene, and the characters those with whose qualities you have become so well acquainted by daily contact in the conduct of your part in the game of railroading?

For the three best stories received at our office in the Woolworth Building, New York, on or before April 1, 1920, we offer a first, second and third prize of $75, $50 and $25 respectively. All stories accepted for publication will be paid for on acceptance at our regular space rates and any received in time will be published in the issues intervening before the contest closes. After the competition closes those to whom the prizes are awarded will receive the prize in addition to the amount paid for the story at space rates. Although there are no conditions other than those already mentioned, it is suggested that a good story of this kind can probably be told within the limits of 1,200 to 2,500 words.

In judging the relative merits of the stories submitted and selecting the prize winners we shall, of course, give some attention to the use of English and the literary finish. But do not be unduly concerned by this fact, for we shall give far more weight to the theme of the story, the quality of the plot, the ability to reproduce the atmosphere of the surroundings, the truth of the character portrayal and the naturalness with which the plot is developed.

Try it and see how it goes.

Why Your Copy Is Late

Because of labor difficulties the publication of the October and November issues of the *Railway Mechanical Engineer* has been greatly delayed. The October issue was held up when it was practically ready for mailing and work was not resumed for two months. The difficulties have now been settled and all the issues will be brought out as quickly as possible. It is expected that the usual schedule will be resumed within a few weeks. In the meantime we must ask the indulgence of our readers if they do not receive their copies promptly.

Economy and the Test Department

The high cost of labor and of the materials needed in railroad work makes it imperative that nothing be left undone that will tend toward economy of operation. A most important adjunct to the modern railroad organization is the test department, and if it is given the wholehearted co-operation of both the managing and the operating officials it can do most effective work. Too often the cost of making a test is allowed to stand in the way of securing data that would mean a lasting improvement in the operation of the locomotive or some other part of the equipment. This is a short-sighted policy—one that is penny wise and pound foolish. Frequently a saving effected in material or an increase in the efficiency of some particular part of the railroad equipment is due

entirely to the work of the test department, and these improvements, if given proper attention by those charged with the daily operations, will produce lasting results. It is a noticeable fact that those railroads having the most active test departments are usually the most efficient. Give the test department an adequate force of engineers and the proper co-operation, and beneficial results will surely follow.

Injustice to Helpers and Apprentices

That portion of the shopmen's new agreement with the Railroad Administration which affects the car shop stipulates that in certain cases helpers or apprentices who have served two or more years may be promoted to mechanic with a mechanic's rate of pay. This is very good and an incentive to good work on the part of a helper or apprentice. Another clause of the agreement, however, provides that if a mechanic having had four or more years' experience applies for work, the helper or apprentice so promoted must be demoted and the mechanic put at work. This is an injustice to the demoted helper and apprentice and is certain to become a source of dissatisfaction. This rule applied, as it evidently is intended to be, may cause the demotion or even discharge of good workers, who may perhaps have homes in the vicinity of the shop in question, to make a place for itinerant mechanics who shift about from shop to shop, and in actual service rendered are not equal in value to a good helper or apprentice. This rule should be given further consideration and changes made so that there may be some discretion on the part of the shop officials as to the demotion of any helper or apprentice under such circumstances.

Development of Shop Foremen

A vital factor in an efficient shop organization is the staff of foremen, and their selection must be given more careful consideration than has been the case in the past. Under the conditions which prevailed in the industrial world until recent years the foreman did not occupy a position of great responsibility, except as he was directly concerned in the work turned out by his department. The foreman was usually selected for his own ability to perform the manual tasks of his craft and so judged as being qualified to direct others. Where the organization was a small one and the superintendent or owner in close touch with the men this practice served very well. But with the expansion of industries this intimate contact has been lost and the shop foremen have become a very vital cog in the organization wheel. The ideal foreman of the present is one who not only is proficient in his craft, but who has the tact necessary to smooth out diplomatically the friction resulting from the real or fancied grievances of the workers. In short, the modern foreman must not only direct the work of his subordinates, but must also act as an intermediary between employer and employee, and this last is a quality that must be brought to the fore if the lion and lamb—employer and employee—are ever to lie down together peacefully.

This condition applies just as much to the railroads as to industries in general and with the return of the roads to private operation the need for foremen of high calibre will become more pressing. While the selection of foremen is given careful consideration on many railroads, most roads make practically no attempt to train men for such positions. Would not a training school conducted along the lines of the officers' training camps, which gave such splendid results in the rapid development of the American army, be a long step toward the solution of the foreman problem? It would be quite possible for a number of the larger railroads to conduct such schools within their own organizations, but for the greater number of railroads this would be impracticable and the benefits to be derived, by the larger as well as the smaller roads, would be much greater in a general training school. To this school might be sent not only men who gave promise of developing into competent foremen, but also those men already occupying the position of foreman. Many of the latter would benefit, by the close contact with others in similar positions, to an extent that is not possible in conventions of the foremen's organizations now in existence. Further, the incentive given to young men in the shops to qualify for a term in such a school and a place on a foremen reserve list would result in more efficient work by the individual and consequently a more efficient shop as a whole.

The plan would involve a general training school supported by the railroads pro rata; men detailed to the school on the basis of shop performance and a foreman's reserve list. The results would be felt in increased efficiency and would insure a source of qualified men for positions of authority.

Paint the Steel Cars

The poor condition of great numbers of steel cars, particularly gondola and hopper cars, is very apparent, as may be seen in any railroad yard, and not the least of the defects is the lack of paint. Recent observations of such cars in various parts of the country showed a large number to be scaled so badly that it was possible to pick off great patches of the paint with the hand. The steel plate underneath paint scaling in this manner is so rusted that it is a question of only a short time before such cars will be useless without extensive repairs to the car body. This condition at the present time is partly due to the necessity of keeping this class of car—used largely for coal—in service, but there is a limit beyond which this is not justifiable. There has been considerable difference of opinion among railroad master painters as to the best method of painting such cars, but it is obvious that the progress of decay—rust—must be stopped and the steel protected from further injury by the elements. If no better method can be found, the surface should be thoroughly cleaned by a sand blast, using a fine screened sand gravel, and then given a priming coat and a finish coat of a good linseed oil paint. Various substitutes for linseed oil have been tried and found wanting. There has also been much criticism of the paint specification called for by the Railroad Administration and this phase of the question should be given attention, as it would be very poor practice to apply paint that is not suitable for the purpose and will not give satisfactory service. Paint the steel cars and do it before it is too late.

Bearing Pressures on Tender Truck Journals

The lubrication of locomotive tenders is recognized as a matter that requires constant attention at terminals. In spite of the fact that the journal boxes are inspected every trip and repacked if necessary, many roads find it advisable to run hose from the tank to each wheel as a precaution against delays due to hot boxes. Such conditions apparently indicate that the loads on tender journals are becoming excessive. Designers will no doubt protest that the weights carried are generally within the limits prescribed by the Master Car Builders' Rules for the association's standard sizes of journals. It is true that the limit weights have seldom been exceeded, but standards established for freight cars are not necessarily applicable to locomotive tenders. An analysis shows that some of the conditions met in tender service are favorable for good lubrication while others are unfavorable and in the end actual

service results alone deserve to be considered. The weight of a tender when loaded can seldom be distributed equally between the front and rear trucks; furthermore, the surging of the water causes periods during which one side carries an undue share of the load. On the other hand, tenders are never fully loaded over the entire division.

Since the total weights of tenders for large locomotives often reach the limit of weight for four 6 in. by 11 in. journals, the next logical step to reduce the unit bearing pressure is the adoption of the six-wheel truck. It is interesting to note that one road which has used six-wheel tender trucks for several years has made this type standard for new power. While the adoption of six-wheel trucks is dictated by the necessity of overcoming the difficulties of lubrication, the change to the longer wheel base will probably show good results in a reduction of wear on wheel flanges and better riding qualities as well.

What About the Valve Setter?

There are probably few jobs within the whole range of locomotive repair work which, if they have the right kind of pride in good workmanship, the men performing them do not feel they are among the most highly essential to the best service of the locomotive. If the opinion of these men were to determine what jobs should carry with them a differential above the minimum established rate because of some special skill or care required for their proper performance, the result would be a much longer list than the comparatively few differentials fixed in the wage agreement between the Railroad Administration and the shop crafts, which went into effect October 20 last. As far as one set of rules can be made to meet the many sets of conditions as to shop practice and equipment which must be dealt with in the United States, the list of differentials established in this agreement may be considered fairly comprehensive. There is one notable exception, however, the high degree of skill for the proper performance of which is generally recognized. That is valve setting. The valve setter's work is reflected in the cost of operation of the locomotive for the entire period between shoppings. It is true that with the prevalence of outside valve gears on modern locomotives, the value of the skill of the old time valve setter may easily lost sight of. Even with these gears, however, a high degree of skill is required not only properly to maintain the correct steam distribution, but to get the work done without wasting a lot of time. Furthermore, the fact must not be lost sight of that there are still a large number of old locomotives with inside valve gears in service and as long as these engines run they burn coal, which is no less valuable because it may be consumed in branch line rather than in main line service. The valve setter's job is still one requiring a degree of skill and intelligence above the average and the only way to secure such a degree of skill and intelligence is to pay adequately for it.

Reinstating the Rules of Interchange

During the period of federal control the Rules of Interchange have been modified by circulars and by local agreements and some of the most important provisions have been suspended. When the railroads are turned back to their owners on January 1, it will be necessary to put the rules into effect once more in their entirety. Present conditions indicate that this will prove a serious task. Although some of the modifications of the rules have been recalled and defect carding has been reestablished, the regulations governing interchange are not being observed as they were prior to federal control. The men who were familiar with the workings of the rules prior to 1918 will not find it difficult to carry them out when they are once more put into force. Few changes have been made in the rules themselves during the period of federal control. For the most part the old rules have been retained and necessary modifications have been taken care of by supplementary circulars. Among the important changes appearing in the 1919 code of rules is the revision of Rule 32 to clarify fair and unfair usage and the addition of Rule 66 providing for the periodical repacking of journal boxes. Rule 88 has also been modified to facilitate repairing foreign cars and Rule 120 has been reinstated as issued in Circular 25.

With the small number of modifications of the rules and with experienced inspectors to form the basis of the new organization, it should not be difficult to put the rules in force once more if a concerted drive is made now to educate the new men. Railroad mechanical officers should consider that the period of federal control will soon be ended and should take immediate steps to insure that all car inspectors become conversant with the new rules in order that there may be no difficulty in putting them into effect on January 1. In order to assist our readers, the editors will welcome discussions of disputed points and will try to answer in the car department section any questions which are sent in regarding the application of the rules.

NEW BOOKS

Official Proceedings of the Eleventh Annual Convention of the Master Boiler Makers' Association.—192 pages, illustrated, 6 in. by 9 in. Bound in cloth. Published by the secretary, Harry D. Vought, 95 Liberty street, New York.

A complete report of the convention of the association, held at the Hotel Sherman, Chicago, Ill., May 26 to 29, 1919. Of especial interest are the committee reports and the discussion on "Threading Radial Stays and Tapping Holes for Same" and "The Best Method of Bracing Locomotive Tenders." The book is very well compiled and nicely bound and reflects credit on the association.

Storing. By H. B. Twyford. 200 pages, illustrated, 6 in. by 9 in., bound in cloth. Published by D. Van Nostrand Company, 25 Park Place, New York.

The necessity for storing stocks of materials of various kinds arises from the practical impossibility of obtaining a constant and uniform flow of materials from the raw state to the finished product at the point of consumption, and with the growing complexity of the modern industrial operations storage problems have also grown in complexity as well as in importance. In its broadest sense, the problem of modern storage not only involves questions of efficient methods of protecting and handling material, but many questions of a commercial nature must also be considered. In this volume the author has attempted to consider the whole range of questions involved in the storage problem, both economic and technical. The former are dealt with in a general way only, defining the fundamentals, and pointing out some of the more common mistakes of an economic nature. The technical problems are dealt with at greater length. Two chapters are devoted to the question of location, equipment and appliances for the storeroom, while the greater part of the work deals with storehouse operations, including discussions of clerical work, the storehouse organization and methods of accounting for and disposing of material received and delivered from the storeroom. Although, beyond the rather general discussion of the economic phases of storing, it has been the intention of the author to confine the discussion to the problems of the storekeeper rather than to include the related problems of purchasing, a brief discussion of the value of stores inventories is included. The book contains a large number of illustrations showing storehouse equipment and methods of handling material, as well as various forms required in properly listing and accounting for stores stock.

COMMUNICATIONS

INADEQUATE MAIN DRIVING BOXES

To the Editor: Allston, Mass.

In reply to Mr. Prescott's communication, appearing in your issue of September 1919, as to an error in quoting the taper of wedges, I would say that the locomotives under my observation have that taper and my statement in relation to the coefficient of friction holding them in position against the piston thrust along the zero line is practically acknowledged by his figures. That is to say, if the resulting moment of slip is 1 in. per ft., ¾ in. per ft. will be 25 per cent inside of the resulting moment.

As regards the spring thrust equipped wedges my observation of locomotives so equipped is, that where they do not hold the box as regards wedge adjustment, they do not cure the other troubles which cause the main driving box to pound.

The tendency of a wedge to unload may be demonstrated in practice in this manner: If, when on the road, a wedge should stick solid, the man running the locomotive will often get down and slack off the check nut supporting the wedge, leave the other two nuts below the wedge support locked together, and then drive the engine without any attempt to pull the wedge down, with the result that on arriving at the terminal point all that is necessary is to set the wedge up.

As an example of an opposite condition, we may assume a wedge forced up with a rigid wedge bolt, causing a tension strain from the wedge sticking, thus causing the bolt to part and the wedge to crawl up and stick. In this case the resistance offered to the wedge by the rigid wedge bolt below causes still further overload with a final result that oftentimes it is necessary to take down the pedestal brace and spring the jaws of the frame open to release the wedge.

These examples are intended to show that my line of thought is not in the direction of an equipment to do away with adjustment, but to argue for a more general application of an equipment to compensate for inequalities which, at times, it may be impossible for the persons concerned to conceive. If practice teaches us the wedge will unload, make provision for it when natural causes make it necessary.

My argument against the spring thrust is this: The physical law is that action and reaction are opposite and equal. In this case the wedges must unload against resistance, which means work set up against the force exerted to unload, and this brings us back to the horizontal along the zero line of the piston.

As to the boring out of the crown of the brass I have this to say: Twenty-eight years ago, as an apprentice, I observed the practice of filing out the crown of the brasses, after being perfectly fitted to the shaft, as the last operation before applying them to the shaft. At this time the oil groove was in the top of the crown and I have seen these boxes, after the locomotives were running, fitting the journal so tight that you could fill the oil hole with engine oil and not have the oil leak down around the sides of the journal.

Since that time, as locomotives increased in size to meet the needs of the transportation department, the oil groove has been moved down near to the zero line of the piston in the crown brasses, and the brasses are now scraped out in line with the piston thrust before they are run, in order to make them slightly larger than the journal and bear hard in the crown, which is directly opposite to the former practice.

In new locomotives coming direct from the builders the crown brasses are splined out one inch back into the crown in direct line with the piston thrust, which would indicate that the trouble was caused by the brasses gripping the journal across the zero line of the piston thrust.

This was the condition on locomotives equipped before the advent of the grease lubricated driving box and the trouble experienced when running at high speed was, perhaps, the cause of bringing about the grease equipped driving box.

At the same time that this trouble was experienced in running high speed locomotives equipped with oil I have seen both heavy Consolidation and switching locomotives shopped, with high mileage, on which the boxes would have to be scraped out in line with the piston thrust in order to get them back on the journal. These locomotives were shopped to turn the tires before the laws governing these things were in vogue and sometimes had ⅜-in. tread wear.

My purpose in speaking of these facts is to try to show that the generating of heat in high speed service is a factor which causes wear in line with the piston thrust.

I will state also that my observation of the way in which the wear takes place in heavy locomotives running at high speed, with high piston thrust, leads me to the conclusion that if a bearing was so designed as to completely surround the journal in direct line with the piston thrust that they will still continue to wear and pound if no provision is made in the design to compensate for the distance to the outside of the bearing beyond the neutral axis of the journal.

Friction is measured by the weight, the load being greatest at the point most distant from the neutral axis and no rigid parallel condition in line with the journal across the frames will meet the requirements of bringing sufficient surface into play to compensate for the tendency of the bearing to wear at the outside and next to the wheel hub.

I am in agreement with Mr. Prescott in regard to the importance of growing piston thrust and also as to the importance of getting into it at this time when the tendency in building is in the direction of simple engines and superheat, with greater mean effective pressure at high piston speed and increasing tractive effort. If we do not talk now and get the changes made, the locomotives will do the talking later on. John C. Murdock.

THERMIT vs. AUTOGENOUS WELDING

New Haven, Conn.

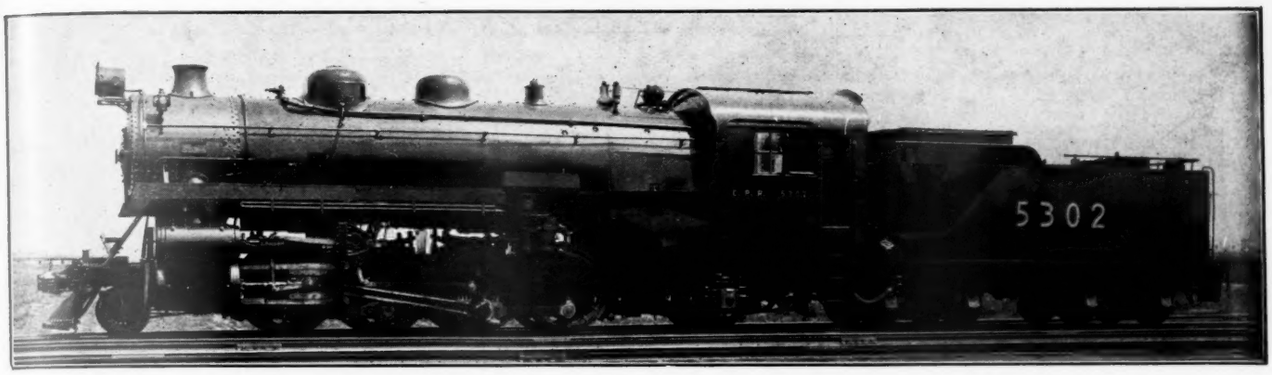
To the Editor:

In his letter in the July issue of the *Railway Mechanical Engineer* E. A. Murray quite pertinently sets forth the advantage of the Thermit process for a job such as he described. But apparantly the damage was confined to distortion of members requiring straightening. The photograph and description do not disclose that there was any breaking up of the frame, as was the case with the frame welded at New Haven.* An inspection of the photograph shown on page 99 of the February, 1919, issue discloses the fact that both ends of the frame were practically destroyed. At each end, as far back as the transom member, the casting was broken up into many pieces, some so small as to be impossible to replace and for which it was necessary to substitute flanged steel plates, which were partly riveted and partly welded into place.

Three out of five of the sections making up the under portion of the underframe were distorted so that they had to be cut and straightened, and this portion of the operation of reclaiming presumably was practically the same as that in the case of the frame which Mr. Murray handled.

I have been familiar for a great many years with the merits of the Thermit process and know the fine work which can be done with it under some conditions. But the frame which we welded was so badly broken up that it would have been a physical impossibility to have repaired it with the Thermit process. I am taking the liberty of again bringing the matter up in order that the difference in the nature of the two jobs may be clearly drawn. W. L. Bean.

*See the February, 1919, issue of the *Railway Mechanical Engineer*, page 97.



Mikado Type Locomotive for Canadian Pacific Freight Service

NEW CANADIAN PACIFIC LOCOMOTIVES

Mikado Type for Freight Service; Heavy Frame Construction and Interchangeable Side Rods

BY W. A. NEWMAN
Engineer of Locomotive Construction

THE locomotive building program now being carried out by the Canadian Pacific Railway includes four new types of locomotives; a Mikado type locomotive having a tractive effort of 56,000 lb., two classes of Pacific type locomotives with 43,700 and 42,600 lb. tractive effort respectively, and a Santa Fe type locomotive with a tractive effort of 66,000 lb. All of these locomotives have been designed by the mechanical engineering department of the Canadian Pacific and are being contsructed at the Augus shops in Montreal.

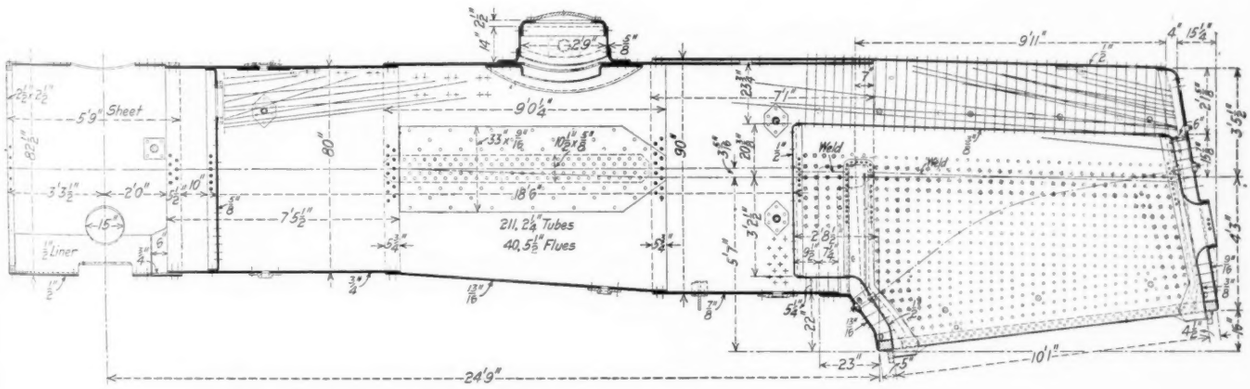
The initial order of 10 Mikado type locomotives has already been completed and one of them is described in this article. The other new types of locomotives are now building and will be described in later issues of this publication.

The design of the Mikado locomotives is largely based on the experience obtained from the earlier Mikado type which was designed and constructed by the Canadian Pacific in 1912. There are no radical departures from what is commonly accepted as standard practice. Close attention has, however, been paid to the design of every detail and no effort spared to produce a common-sense locomotive which will give reliable and efficient service.

The locomotives have a total weight of 320,500 lb., with 235,000 lb. on the driving wheels, which gives a factor of adhesion of 4.18. The cylinders are 25 in. by 32 in., driving wheels 63 in. outside diameter, which with a normal boiler pressure of 200 lb. per sq. in., gives a maximum calculated tractive effort of 56,000 lb.

THE BOILER

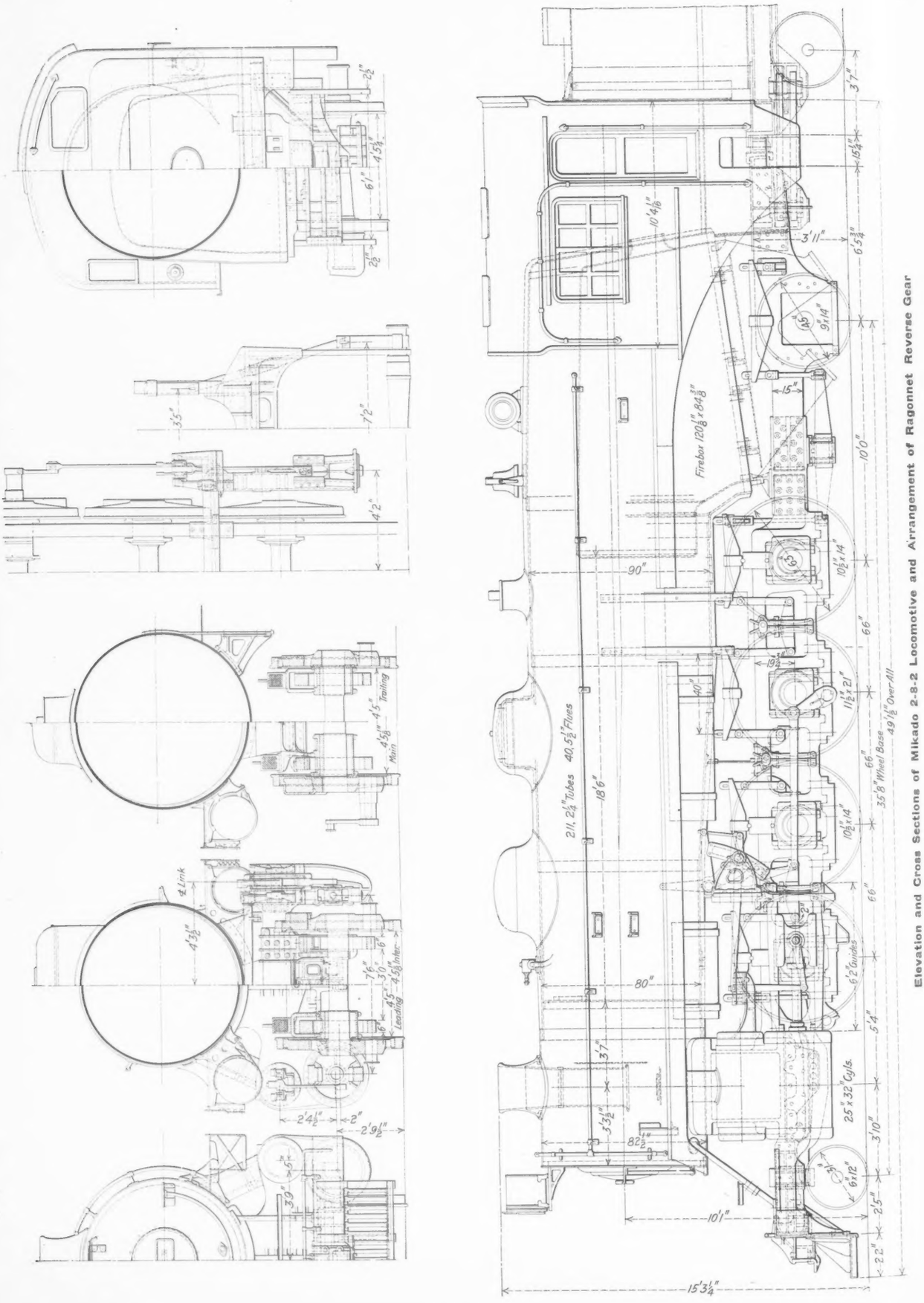
The boilers are of the extension wagon bottom type, and are the first of this kind to be used on Canadian Pacific locomotives. This type of construction was adopted for several reasons: the steam dome can be located on the second course, which simplifies the seam construction on the third course; the standpipe is further away from the crown sheet where the greatest ebullition occurs; it shortens the dry pipe and consequently the length of the steam passage, and provides a greater steam storage space, which should be of material advantage in increasing superheater efficiency.



Extension Wagon Bottom Boiler for Canadian Pacific Mikado Type Locomotive

The boiler design is the result of a very careful study of boiler proportions and construction, every care being taken to insure ample steam generating capacity, combined with easy steaming qualities. The smallest details of construction were given close attention with ease of maintenance in view.

The capacity of the boiler in relation to the cylinder requirements is 102.5 per cent, based on Cole's ratios. The

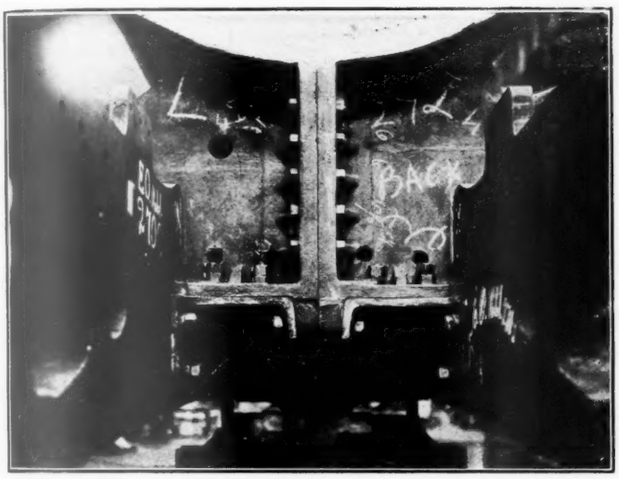


Elevation and Cross Sections of Mikado 2-8-2 Locomotive and Arrangement of Ragonnet Reverse Gear

length of tubes is 18 ft. 6 in., which is a close approximation of the most efficient ratio of tube length to diameter. A 28-in. barrel combustion chamber is used, this being the first combustion chamber of this type on the Canadian Pacific Railway. The mudring ends are of cast steel welded to wrought iron side pieces. The ends have drop corners to allow through riveting for the corner fastening of the inside firebox sheet.

THE FRAMES

The frames are a little heavier than is usually found in general locomotive practice. This is chiefly on account of the difficulty experienced with frame breakages, particularly in sections of Canada in which extremely low winter temperatures are experienced. The frames are of the single front rail type and it has been the experience of the Canadian Pacific that the majority of breakages with such frames come directly behind the cylinders. This apparently has been largely due to insufficient fastening to the cylinders and on account of the twisting strains set up due to the narrow bolting face of the cylinders in comparison with the total depth of the frame through the pedestals. In an attempt to correct this, a 15-in. depth of frame section at the back of the cylinders has been used and an extension lug carried forward from the top rail of the frame, which engages with and bolts to a vertical lug on the back wall of the cylinder casting. This gives a total vertical bolting face at the back of the cylinders of 29½ in., which it is expected will effectively counteract any twisting strain to which this section of the frame will be subjected. This construction is shown in detail in the illustrations.



Special Wedge Casting to Reinforce the Frame and Cylinder Casting

In addition to being bolted to the usual side vertical bolting face underneath the cylinders, each frame is further secured by being bolted through a casting which extends between the locomotive frames and bears against extension lugs at the center of the cylinder castings. These lugs have a tapered face, and the whole casting is first driven in place, secured by vertical bolts, and then bolted horizontally through the frame and cylinders.

The frames are of a uniform width of 6 in. throughout. The depth of section at the top of the pedestal is 6¾ in., the minimum depth of the top rail between pedestals 5¾ in., and the minimum depth at the bottom rail 4½ in.

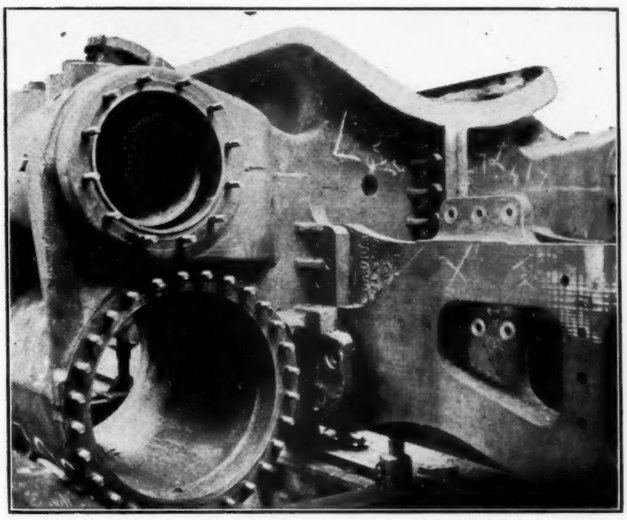
TRAILING TRUCK

The locomotives are equipped with the Vaughan trailing truck, the extension frame being outside the trailing wheels and spaced 6 ft. 3½ in. center to center. No radius bar is used with these trucks, the guiding motion being obtained from inclined vertical faces on the journal boxes which bear against faces having the same incline, on the pedestals attached to the extension frame. This type of truck has been used on Canadian Pacific locomotives for the past 13 years and has given satisfactory service.

ASH PAN AND GRATES

The chief advantages of this construction of rear frame are simplicity and that an ash pan of ample capacity can be obtained with very few relatively flat horizontal surfaces, as will be seen by a study of the ash pan drawing. An ash pan of ample capacity and with quick slopes is absolutely imperative for locomotives operating in cold climates, and a great deal of attention was given to the design of this ash pan. As far as possible, all corner angles are located outside the pan and straight joints in the plate formed by flanging the plate to the outside, the joint being made with sheet asbestos. This construction removes a great many bolt heads from the inside of the pan. The ash pan doors are of the swinging type and are supported from pivot points located back of the door center of gravity, so that the doors are self-closing by their own weight. This is particularly advantageous from a standpoint of fire risk. The ash pan is supported by a combination cast steel bracket, which also forms a support for the grate side carriers.

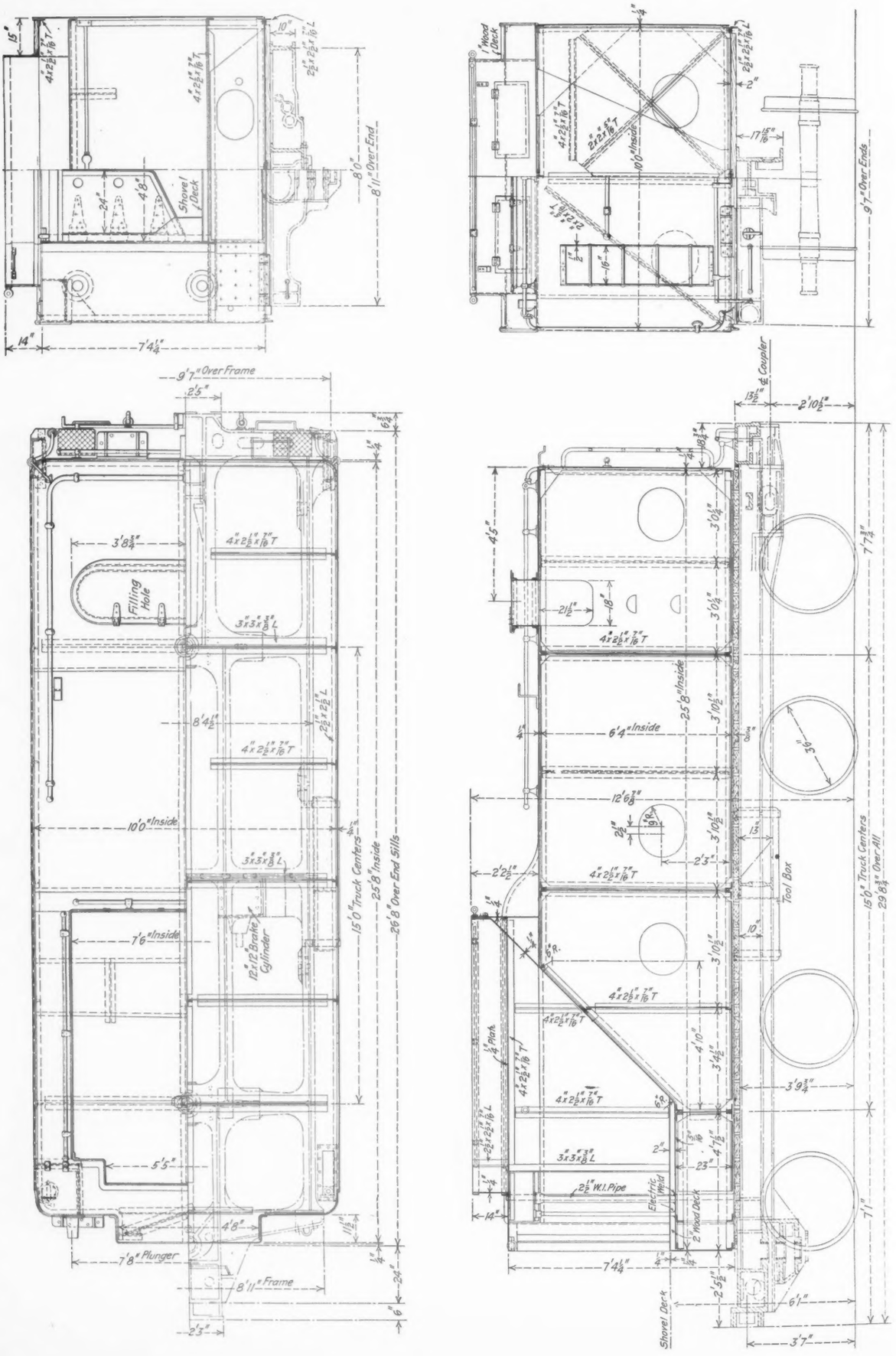
The grates are of the butt finger type, 10 in. wide, are in four sections, and are all moving grates. Dead grates at the front and back have been eliminated. The center carrier is of very light cast steel construction and is reinforced along the bottom or tension member by a structural tee iron, shrunk in place and riveted. Careful attention was given to the design of the grate side carriers to eliminate warping. The design finally adopted has the side carriers in two sections. This permits a stiffer construction and also facilitates any repairs to firebox corners, as only one section of the grates need be removed.



Extension Lug on the Frame Bolted to Vertical Lug on the Cylinder Casting

RODS AND MOTION WORK

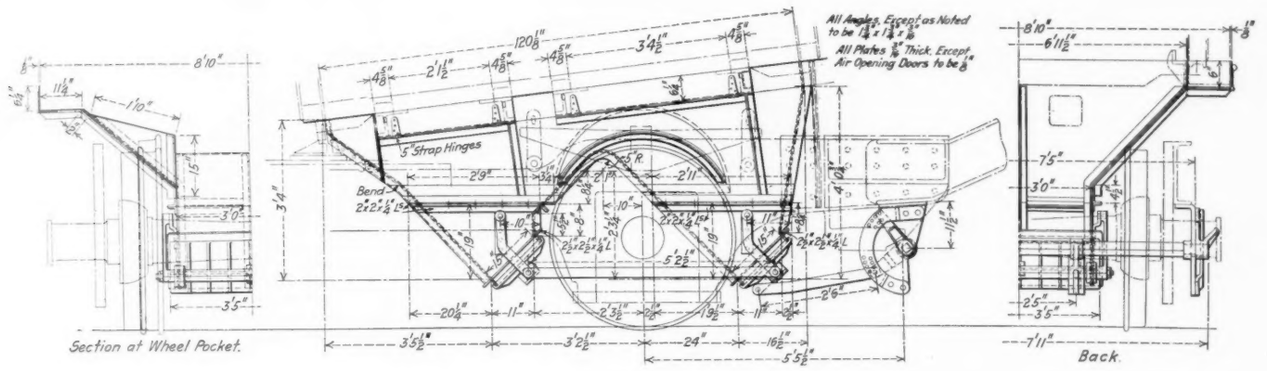
The main and side rods are of ordinary carbon steel and present no unusual features, except that the front and back side rods have been made interchangeable; that is, the back right and front left side rods are identical. The piston heads are of cast iron and are considerably lighter than heads two inches smaller in diameter which have been used as standard on other Canadian Pacific locomotives. This is



Two-Piece Water Bottom, 8000 Imperial Gal. Capacity Tender with 45 Deg. Coal Sheet and Special Swash Plate Bracing

the result of a very close analysis, both mathematically and by actual tests, of the stresses in piston heads. The crosshead is a modification of that previously used as standard by the Canadian Pacific. The body of the crosshead is cast in one piece and takes removable cast iron wearing pads, which are in three sections, top and bottom, and are retained in place by side plates which are bolted to the crosshead body.

The union link connection to the crosshead is slightly unusual. It is apparently carried by the wrist pin, but actually works on a bearing which is part of the inside

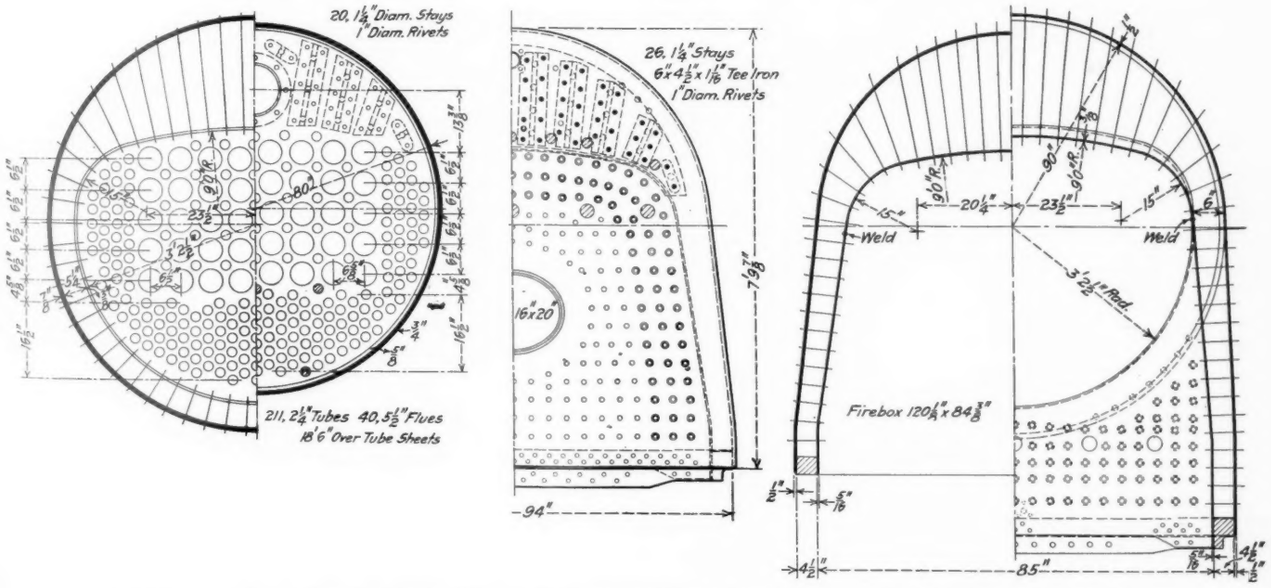

All Angles, Except as Noted to be 4" x 4" x 7/16"
All Plates 7/16" Thick, Except Air Opening Doors to be 3/8"
5" Strap Hinges
Bend
Section at Wheel Pocket.
Back.

Arrangement of Ashpan for Canadian Pacific Mikado Locomotive

washer. This washer fits on a tapered shoulder on the crosshead body, so that the wrist pin is relieved of any thrust from the union link.

Although all motion parts are of ordinary carbon steel, particular attention has been given in their design, to the reduction of weight, with the result that the reciprocating parts are only 96 lb. heavier than those used on the lighter

man's seat in the usual position ahead of the fireman's seat and between the firebox and the cab side. The cab is of the Canadian Pacific standard vestibule type, and it was finally decided to locate the brakeman's seat directly behind the fireman's. The vestibule cab includes two lockers, one on either side of the cab, back of the doors. To make room for the brakeman's seat, the locker on the left hand side



Half Views of Front Firebox Sheet, Front Tube Sheet and Back Head and Section Through Firebox at Throat

Mikado type engine, which is an increase in weight of 5.87 per cent, as against an increase in piston load of 31 per cent.

SAND BOX AND CAB FITTINGS

An oval sand box is used which has a capacity of 20 cu. ft. This is of built-up construction, the bottom being

was omitted and the height of the locker on the right side increased to six feet. A fold-up brakeman's seat was then located on the left side in such a way that with the seat dropped in place and the door closed, a drop panel in the door forms a window to enable the brakeman to look out. This window is provided with a small arm rest of the usual construction, which folds inward when the door panel

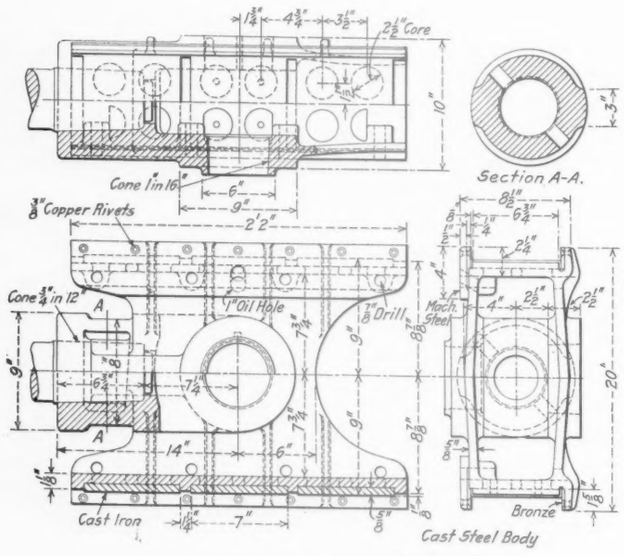
is raised. The locker on the right side of the cab is divided into two parts, the 4-ft. upper locker being lined with wood and furnished with coat hangers to take the crew's clothes. The bottom locker is used for supplies, and the signal equipment is carried in a wire rack located under the roof of the cab.

THE TENDER

The tender is of the water bottom construction with a total capacity of 8,000 Imperial gallons, which is equivalent to 9,600 American gallons, and has a coal capacity of 12 tons. The slope of the back coal sheet is 45 deg., which is sufficient to insure that all the coal is fed to the front of the coal space, and dispenses with the use of a coal pusher. This is Canadian Pacific standard construction, all locomotive tenders being fitted in this way. The tank bottom is in two pieces, having one longitudinal butt joint with inside and outside welts. The swash plate bracing has been very carefully worked out in order to eliminate all unnecessary strains on the riveting and to insure freedom from trouble from leaky tenders. The tank is supported by a Commonwealth one-piece cast steel underframe. The tender trucks are of the equalizer type with combination semi-elliptic and coil springs.

SPECIAL EQUIPMENT AND AIR BRAKE

These locomotives are equipped with Security brick arches, Cole extension main driving boxes, Franklin automatic driving box wedges, Franklin radial buffers, Franklin unit safety bar (of standard C. P. R. laminated design), Franklin vertical type steam grate shakers, Franklin No. 8 automatic firedoors, Economy engine truck, Nathan type "T" top checks, World safety valves, Detroit lubricators, Hancock non-lifting type "H. N. L." inspirators on the left



Crosshead With Cast Iron Wearing Pads

side, and Hancock type "A" lifting inspirators on the right side, Ragonnet reverse gear, Never-Clog air-sanders and Pyle-National turbo generators with incandescent headlights.

The air brake is the Westinghouse schedule "ET" with cross-compound air compressors. Ample cooling surface is provided in the air brake piping, 2-in. pipes being used between the compressor and the first reservoir. A parasite reservoir is also part of the air system with which this locomotive is equipped, and the pressure is controlled by a Westinghouse Parasite governor.

The locomotives are hand-fired and have proved exceptionally easy steamers, and quite live up to the expectations of economy in coal and water.

The principal data and dimensions are as follows:

General Data

Gage	4 ft. 8½ in
Service	Freight
Fuel	Bit. coal
Tractive effort	56,147 lb.
Weight in working order	320,500 lb.
Weight on drivers	235,000 lb.
Weight on leading truck	28,000 lb.
Weight on trailing truck	57,500 lb.
Weight of engine and tender in working order	498,600 lb.
Wheel base, driving	16 ft. 6 in.
Wheel base, total	38 ft. 8 in.
Wheel base, engine and tender	68 ft.

Ratios

Gage	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	56,147 lb.
Weight in working order	320,500 lb.
Weight on drivers	235,000 lb.
Weight on leading truck	28,000 lb.
Weight on trailing truck	57,500 lb.
Weight of engine and tender in working order	498,600 lb.
Wheel base, driving	16 ft. 6 in.
Wheel base, total	35 ft. 8 in.
Wheel base, engine and tender	68 ft.
Weight on drivers ÷ tractive effort	4.18
Total weight ÷ tractive effort	5.7
Tractive effort × diam. drivers ÷ equivalent heating surface*	717
Equivalent heating surface* ÷ grate area	70.1
Firebox heating surface ÷ equivalent heating surface,* per cent	9.47
Total weight ÷ equivalent heating surface*	65.0
Volume both cylinders	18.9 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	261.0
Grate area ÷ vol. cylinders	3.72

Cylinders

Kind	Simple
Diameter and stroke	25 in. by 32 in.

Valves

Kind	Piston
Diameter	14 in.
Greatest travel	6½ in.
Outside lap	1⅛ in.
Inside clearance	⅛ in.
Lead in full gear	3/16 in.

Wheels

Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11½ in. by 21 in.
Driving journals, others, diameter and length	10½ in by 14 in.
Engine truck wheels, diameter	31 in.
Engine truck, journals	6 in. by 12 in.
Trailing truck wheels, diameter	45 in.
Trailing truck, journals	9 in. by 14 in.

Boiler

Style	Extended wagon bottom
Working pressure	200 lb. per sq. in.
Outside diameter of first ring	80 in.
Firebox, length and width	120⅛ by 84⅜ in.
Firebox plates, thickness	Tube ½in., crown and back ⅜ in, sides 5/16 in.
Firebox, water space	Front 5 in., back and sides 4½ in.
Tubes, number and outside diameter	211, 2¼ in.
Flues, number and outside diameter	40, 5½ in.
Tubes and flues, length	18 ft. 6 in.
Heating surface, tubes and flues	3,347. 78 sq. ft.
Heating surface, firebox, including arch tubes	317 sq. ft.
Heating surface, total	3,664.78 sq. ft.
Superheater heating surface	845 sq. ft.
Equivalent heating surface*	4,932.28 sq. ft.
Grate area	70.3 sq. ft.

Tender

Tank	Water bottom
Frame	Cast steel
Weight	178,100 lb.
Wheels, diameter	36 in.
Journals, diameter and length	6 in. by 11 in.
Water capacity	8,000 imp. gal.
Coal capacity	12 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

BRAZILIAN COAL.—According to the British Chamber of Commerce in Brazil, it is reported that experiments have recently been made by the Central Railway with briquettes composed of national coal from the Caçapava mines and American fuel. The experiments, which were carried out under strict technical requirements, gave excellent results and fully satisfied the experts who were present. It is believed, says the Chamber of Commerce, that the tests made with the Caçapava coal, from mines in the state of Sao Paulo, situated close to the Central Railway, with which it will shortly be linked up by a branch line of 12 km., may eventually lead to a decrease of over 50 per cent in the imports of American coal making an appreciable economy.

SHOP EMPLOYEES' WAGE AGREEMENT

Negotiated with Railroad Administration; Includes the Wage Adjustments and Working Conditions

Director General Hines entered into the following agreement, effective October 20, with the shop employees on roads under federal operation, represented by the Railway Employees' Department of the American Federation of Labor and it affiliated organizations of the Mechanical Section and Divisions Nos. 1, 2 and 3, thereof, including the International Association of Machinists, International Brotherhood of Boilermakers, Iron Ship Builders and Helpers of America, International Brotherhood of Blacksmiths and Helpers, Amalgamated Sheet Metal Workers' International Alliance, International Brotherhood of Electrical Workers, and the Brotherhood Railway Carmen of America.

It is understood that this agrement shall apply to those who perform the work specified in this agreement in the maintenance of equipment, maintenance of way, signal maintenance (except electricians engaged in signal maintenance, telegraph maintenance and all other departments of all railroads in federal operation, shop employees of American Railway Express, and Pullman Car Line employees having the same working conditions as specified in Supplement No. 4 to General Order No. 27. It is understood that this agreement does not annul agreements already in effect with other organizations unless and until a majority of the employees concerned express a desire for a change.

GENERAL RULES

Hours of Service.—Rule 1. Eight hours shall constitute a day's work. All employees coming under the provisions of this schedule, except as provided for in Rule 15, shall be paid on the hourly basis.

Rule 2. When one shift is employed, the starting time shall be not earlier than 7 o'clock, and not later than 8 o'clock. The time and length of the lunch period shall be subject to mutual agreement.

Rule 3. Where two shifts are employed, the starting time of the first shift shall be governed by Rule 2, and the second shift shall start immediately following the first shift, or at 8 p. m. The spread of the second shift shall consist of eight consecutive hours, including an allowance of 20 minutes for lunch within the limits of the fifth hour.

Rule 4. Where three shifts are employed, the starting time of the first shift shall be governed by Rule 2, and the starting time for each following shift shall be regulated accordingly. The spread of each shift shall consist of eight consecutive hours, including an allowance of 20 minutes for lunch within the limits of the fifth hour.

Rule 5. The time established for commencing and quitting work for all men on each shift shall be the same at the respective points, but where three shifts are worked by running repair forces, and two shifts by back shop forces, the quitting time of the first shift and the commencing and quitting time of the second shift of the back shop forces will be governed by the provisions of Rule 3.

Exception.—It is agreed that three eight hour shifts may be established under the provisions of Rule 4, for the employees necessary to the continuous operation of power houses, millwright gangs, heat treating plants, train yard running repair and inspection forces (not repair tracks) without extending the provisions of Rule 4 to the balance of the shop forces.

Rule 6. All overtime, except as the provisions of Rules 7, 9, 10 and 15 apply, outside of bulletin hours, up to and including the sixteenth hour of service in any one 24-hour period, computed from the starting time of the employee's regular shift, shall be paid for at the rate of time and one-half and thereafter at the rate of double time, up to the starting time of the employee's regular shift. This to include work performed on Sundays, New Year's Day, Washington's Birthday, Decoration Day, Fourth of July, Labor Day, Thanksgiving Day. Christmas and such state holidays as are now recognized as punitive overtime days at the various points on the respective railroads within the different states.

Rule 7. For continuous service after regular working hours, employees will be paid one hour for forty minutes' service or less, and shall not be required to work more than one hour without being permitted to go to meals. Employees called or required to return to work will be allowed five hours for three hours and twenty minutes' service or less. They shall be required to do only such work as held or called for.

Rule 8. Employees regularly assigned to work on Sundays or holidays, or those called to take the place of such employees, will be allowed to complete the balance of the day unless released at their own request. Those who are called will be advised as soon as possible after vacancies become known.

Rule 9. Employees required to work during lunch period shall receive pay for one hour straight time and be allowed necessary time to procure lunch without loss of time. This does not apply where employees are allowed the twenty minutes for lunch without deduction therefor.

Rule 10. Employees, except as the provisions of Rules 12 and 15 apply, sent out on the road for emergency service, shall receive continuous time from the time called until their return as follows:

Overtime Emergency Service Road Work.—Overtime rates for all overtime hours and straight time for the recognized straight time hours at home station, whether working, waiting or traveling, except that after the first 24 hours, if relieved from duty and permitted to go to bed for five or more hours, they will not be allowed time for such hours, provided that in no case shall an employee be paid for less than eight hours on week days, and eight hours at one and one-half time for Sundays and recognized holidays, for each calendar day. Where meals and lodging are not provided by the railroad, actual expenses will be allowed. Employees will receive all allowances for expenses not later than the time when they are paid for the service rendered. Employees will be called as nearly as possible, one hour before leaving time, and on their return will deliver tools at point designated.

Rule 11. When it becomes necessary for employees to work overtime, they shall not be laid off during regular working hours to equalize the time. At points where sufficient number of employees are employed, employees shall not work two consecutive Sundays (holidays to be considered as Sundays). Record will be kept of overtime worked and men called with the purpose in view of distributing the overtime equally.

Rule 12. When necessary to fill temporary vacancies at outlying points, employees, excluding those specified in Rules 14 and 15, will be sent out and will be paid for this service as follows: Continuous time for time called up to time of reporting at point to which sent, overtime rates for all overtime hours, and straight time for the recognized straight time hours at home station, whether waiting or traveling (the same provisions to apply for return trip). While at such point they will be paid straight time and overtime in accordance with practice at home point with a guarantee of not less than eight hours' pay, at the established rate, for each calendar day, including Sundays and holidays at overtime rates. Where meals and lodging are not provided by the railroad, actual expenses will be allowed. Rules in existing agreements or shop rules covering the road service described in Rules 10 and 12, which are more favorable to the employees, are to be preserved.

Rule 13. Employees changed from one shift to another will be paid overtime rates for the first shift of each change. Employees working two shifts or more on a new shift shall be considered transferred.

Rule 14. Employees regularly assigned to road work whose tour of duty is regular, and who leave and return to home station daily (a boarding car to be considered a home station) shall be paid continuous time from the time of leaving the home station to the time they return, whether working, waiting or traveling, exclusive of the meal period, at straight time for the regular hours, and overtime rates for all overtime hours, as per overtime rules. The starting time to be not earlier than 6 a. m., nor later than 8 a. m. Where two or more shifts are worked, the starting time of each following shift will be regulated accordingly.

Rule 15. Employees regularly assigned to perform road work and paid on a monthly basis, shall be paid not less than the minimum hourly rate established for the corresponding class or employees coming under the provisions of this schedule, on the basis of 365 eight-hour days per calendar year, with pay at the rate of time and one-half time for Sundays and holidays designated herein; otherwise, overtime will not be paid. Where meals and lodging are not furnished by the railroad, or when the service requirements make the purchase of meals and lodging necessary, while away from home point, employees will be paid actual expenses. This service is distinct and separate from that performed by any other class of employees coming under the provisions of this schedule and is not to be confused therewith; the employees assigned to it shall not be assigned to or used to perform the construction, repair and emergency work assigned to the other employees under the provisions of the general and special rules of this schedule.

NOTE

The following is an example to be followed in arriving at the monthly rate:

365 days multiplied by 8 equals	2,920 hours
59 Sundays and holidays at one-half time will be 59 x 4, equaling	236 hours
Total hours to be paid for	3,156 hours

The monthly salary is arrived at by dividing the total earnings of 3,156 hours by 12; no overtime is allowed for time worked in excess of eight hours per day; on the other hand, no time is to be deducted unless the employee lays off of his own accord.

Filling Vacancies.—Rule 16. When an employee is required to fill the place of another employee receiving a higher rate of pay, he shall receive the higher rate, but if required to fill, temporarily the place of another employee receiving a lower rate, his rate will not be changed.

Rule 17. Employees serving on night shifts, desiring day work, shall have preference when vacancies occur, according to their seniority.

Rule 18. When new jobs are created or vacancies occur in the respective crafts, the oldest employees in point of service shall, if sufficient ability is shown by trial, be given preference in filling such new jobs or any vacancies that may be desirable to them. All vacancies or new jobs created will be bulletined. Bulletins must be posted five days before vacancies are filled permanently. Employees desiring to avail themselves of this rule will make application to the official in charge and a copy of the application will be given to the local chairman.

Rule 19. Mechanics in service will be considered for promotion to posi-

tions as foremen. When vacancies occur in positions of gang foremen men from the respective crafts will have preference in promotion.

Rule 20. Employees transferred from one point to another, with a view of accepting a permanent transfer, will, after 30 days, lose their seniority at the point they left and their seniority at the point to which transferred will begin on date of transfer, seniority to govern. Employees will not be compelled to accept a permanent transfer to another point.

Rule 21. When the requirements of the service will permit, employees, on request, will be granted leave of absence for a limited time, with privilege of renewal. An employee absent on leave who engages in other employment, will lose his seniority unless special provisions shall have been made therefor by the proper official and committee representing his craft. The arbitrary refusal of a reasonable amount of leave of employees when they can be spared, or failure to handle promptly cases involving sickness or business matters of serious importance to the employee, is an improper practice and may be handled as unjust treatment under this agreement.

Absence from Work.—Rule 22. In case an employee is unavoidably kept from work he will not be discriminated against. An employee detained from work on account of sickness or for any other good cause shall notify his foreman as early as possible.

Faithful Service.—Rule 23. Employees who have given long and faithful service in the employ of the company and who have become unable to handle heavy work to advantage, will be given preference of such light work in their line as they are able to handle.

Attending Court.—Rule 24. When attending court as witnesses for the railroad, employees will receive pay for all time lost at home station, with a minimum of eight hours' time each week day and eight hours at rate and one-half for Sundays and holidays, either at home station, away from home, or traveling. Time and one-half will be paid for traveling during overtime hours where emplyoees are unable to secure sleeping car accommodation. Actual expenses will be allowed when away from home station, and ncessary expenses will be allowed when at home. When necessary, the company will furnish transportation and will be entitled to certificate for witness fees in all cases.

Paying Off.—Rule 25. Employees will be paid off during their regular working hours, semi-monthly, except where existing state laws provide a more desirable paying off condition. Should the regular pay day fall on a holiday or days when the shops are closed down, men will be paid on the preceding day. Where there is a shortage equal to one day's pay or more in the pay of an employee, a voucher will be issued to cover the shortage. Employees leaving the service of the company will be furnished with a time voucher covering all time due within 24 hours where D. C. checks are issued and within 48 hours at other points, or earlier when possible.

Rule 26. During inclement weather provision will be made where buildings are available to pay employees under shelter.

Reduction of Forces.—Rule 27. When it becomes necessary to reduce expenses, the force at any point or in any department or sub-division thereof shall be reduced, seniority as per Rule 31 to govern; the men affected to take the rate of the job to which they are assigned. Five days' notice will be given men affected before reduction is made, and lists will be furnished local committee. In the restoration of forces, senior laid off men will be given preference of re-employment, if available, within a reasonable time, and shall be returned to their former position; local committee will be furnished list of men to be restored to service; in reducing force the ratio of apprentices will be maintained.

Rule 28. Employees laid off on account of reduction in force, who desire to seek employment elsewhere, will, upon application, be furnished with a pass to any point desired on the same railroad.

Rule 29. When reducing forces, if men are needed at any other point they will be given preference to transfer to nearest point, with privilege of returning to home station when force is increased, such transfer to be made without expense to the company. Seniority to govern all cases.

Rule 30. Employees required to work when shops are closed down, due to breakdown in machinery, floods, fires, and the like, will receive straight time for regular hours, and overtime for overtime hours.

Seniority.—Rule 31. Seniority of employees in each craft covered by this agreement shall be confined to the point employed in each of the following departments: Maintenance of Way (Bridge and Building where separate from Maintenance of Way Department); Maintenance of Equipment; Maintenance of Telegraph; Maintenance of Signals; four subdivisions of the Carmen as follows: Patternmakers, Upholsters, Painters, and other Carmen. The seniority lists will be open to inspection and copy furnished the committee.

Assignment of Work.—Rule 32. None but mechanics or apprentices regularly employed as such shall do mechanics' work as per special rules of each craft, except foreman at points where no mechanics are employed.

Rule 33. In compliance with the special rules included in this agreement, none but mechanics and their apprentices in their respective crafts shall operate oxy-acetylene, thermit, or electric welders; where oxy-acetylene or other welding processes are used, each craft shall perform the work which was generally recognized as work belonging to that craft prior to the introduction of such processes, except the use of the cutting torch when engaged in wrecking service.

Filling Foremanship Temporarily.—Rule 34. Should an employee be assigned temporarily to fill the place of a foreman, he will be paid his own rate, straight time for straight time hours and overtime for overtime hours, if greater than the foreman's rate. If it is not, he will get the foreman's rate. Such positions shall be filled only by mechanics of the respective craft in their departments.

Grievances.—Rule 35. Should any employee subject to this agreement believe he has been unjustly dealt with, or any of the provisions of this agreement have been violated, the case shall be taken to the foreman, general foreman, master mechanic, or shop superintendent, each in their respective order, by the duly authorized local committee or their representative. If stenographic report of investigation is taken, the committee shall be furnished a copy. If the result still be unsatisfactory, the duly authorized general committee, or their representatives, shall have the right of appeal, preferably in writing, to the higher officials designated to handle such matters in their respective order, and conference will be granted within ten days of application. All conferences between local officials and local committees to be held during regular working hours without loss of time to committeemen.

Rule 36. Should the highest designated railroad official or his duly authorized representative and the duly authorized representative of the employees fail to agree, the case shall then be jointly submitted in writing to the chief executive officer of the railroad and the chief executive officer of the Railway Employees' Department of the American Federation of Labor for adjudication or final disposition. The methods of procedure will be those prescribed by the Railroad Administration. To the extent that these rules may remain in force after the expiration of federal operation, the methods of procedure will thereafter be such as may be agreed to by the representatives of the railroads and the representatives of the organizations herein specified. Prior to the assertion of grievances as herein provided, and while questions of grievances are pending, there will neither be a shut down by the employer nor a suspension of work by the employees.

Rule 37. An employee who has been in the service of the railroad 30 days shall not be dismissed for incompetency, neither shall an employee be discharged for any cause without first being given an investigation.

Rule 38. If it is found that an employee has been unjustly discharged or dealt with, such employee shall be reinstated with full pay for all time lost.

Committees.—Rule 39. The company will not discriminate against any committeemen, who from time to time, represent other employees, and will grant them leave of absence and free transportation when delegated to represent other employees.

Apprentices.—Rule 40. All appretices must be able to speak, read, and write the English language and understand at least the first four rules of arithmetic. Applicants for regular apprenticeship shall be between 16 and 21 years of age, and if accepted, shall serve four years of 290 days each calendar year. If retained in the service at the expiration of their apprenticeship they shall be paid not less than the minimum rate established for journeymen mechanics of their respective crafts. In selecting helper apprentices, seniority will govern and all selections will be made in conjunction with the respective craft shop committees. (NOTE: See special rules of each craft for additional apprentice rules.)

Rule 41. All apprentices must be indentured and shall be furnished with a duplicate of indenture by the company, who will also furnish every opportunity possible for the apprentice to secure a complete knowledge of the trade.

No apprentice will be started at points where there are not adequate facilities for learning the trade.

Rule 40 shall govern in the employment of apprentices.

FORM OF INDENTURE

This will certify that.....was employed as a .....apprentice by the.....Railroad, at.....on.....19..., to serve four years, a minimum of two hundred and ninety days each.

.....
(Title of officer in charge.)

SERVICE PERFORMED DURING APPRENTICESHIP

.....
.....
.....
This will certify that on....., 19...., ... completed the course of apprenticeship specified above and is entitled, if employed by the.....Railroad to the rates of pay and conditions of service of.....
.....
(Title of officer in charge.)

NOTE: *The above form is to be used both for regular and helper apprentices. (Helper apprentices to serve 3 years.)*

Rule 42. The ratio of apprentices in their respective crafts, shall not be more than one to every five mechanics. Two apprentices will not be worked together as partners. The distribution of apprentices among shops where general repairs are made on the division shall be as nearly as possible in proportion to the mechanics in the respective trades employed therein. In computing the number of apprentices that may be employed in a trade on a division, the total number of mechanics of that trade employed on the division will be considered. If, within six months, an apprentice shows no aptitude to learn the trade, he will not be retained as an apprentice. An apprentice shall not be dismissed or leave the service of his own accord, except for just and sufficient cause, before completing his apprenticeship. Apprentices shall not be assigned to work on night shifts. An apprentice shall not be allowed to work overtime during the first three years of his apprenticeship. If an apprentice is retained in the service upon completing the apprenticeship, his seniority rights as a mechanic will date from the time of completion of apprenticeship. Preference will be given to sons of employees in the selection of apprentices to the extent of at least 80 per cent of the number employed.

Rates of Pay.—Rule 43. The rate for all mechanics who were receiving 68 cents per hour or more under Supplement 4 to General Order 27, except those provided for in Rule 45, will be increased 4 cents per hour, effective May 1, 1919. Steel car workers and other mechanics in the car department who were receiving the rate of 63 cents per hour, under Supplement 4 to General Order 27, will be increased 4 cents per hour, effective May 1, 1919. Other mechanics in the car department who were receiving 58 cents per hour, under Supplement 4 to General Order 27, will be increased 9 cents per hour, making a rate of 67 cents per hour, effective May 1, 1919.

Rule 44. Apprentices, helpers, and other classes of workmen covered by Supplement 4 to General Order 27, except those provided for in Rule 45, will be increased 4 cents per hour above the present rate, effective May 1, 1919. This increase to apply also to men paid on the step-rates provided for in Section 2 and 2a of Article 2, Supplement 4 to General Order 27, except those provided for in Rule 45, effective May 1, 1919.

Rule 45 Linemen and others covered by Rule 141 shall receive 68 cents per hour, effective May 1, 1919. Groundmen covered by Rule 142 shall receive 62 cents per hour, effective May 1, 1919. Coal pier elevator

operators and coal pier electric hoist operators as covered by Rule 143 shall receive 55 cents per hour, effective May 1, 1919.

Applicants for Employment.—Rule 46. Applicants for employment will be required to make statement only as to their ability, and address of relatives, except when their duties require them to distinguish signals or do flagging when they shall be required to pass the usual eyesight and hearing tests.

Conditions of Shops, Etc.—Rule 47. Good drinking water and ice will be furnished. Sanitary drinking fountains will be provided where necessary. Pits and floors, lockers, toilets and wash rooms will be kept in good repair and in a clean, dry and sanitary condition. Shops, locker rooms and wash rooms will be lighted and heated in the best manner possible consistent with the source of heat and light available at the point in question.

Personal Injuries.—Rule 48. Employees injured while at work will not be required to make accident reports before they are given medical attention, but will make them as soon as practicable thereafter. Proper medical attention will be given at the earliest possible moment, and employees shall be permitted to return to work without signing a release pending final settlement of the case. At the option of the employee, personal injury settlements may be handled under the provisions of Rules 35 and 36. Where death or permanent disability results from injury, the lawful heirs of the deceased may have the case handled as herein provided.

Rule 49. A place will be provided inside all shops and roundhouses where proper notices of interest to employees may be posted.

Shop Trains.—Rule 50. Existing conditions in regard to shop trains will be maintained unless changed by mutual agreement. The company will endeavor to keep shop trains on schedule time, properly heated and lighted, and in a safe, clean and sanitary condition. This not to apply to temporary service provided in case of emergency.

Free Transportation.—Rule 51. Employees covered by this agreement, and those dependent upon them for support, will be given the same consideration in granting free transportation as is granted other employees in service. General committees representing employees covered by this agreement to be granted same consideration as is granted general committees representing employees in other branches of the service.

Rule 52. Employees will not be required to work on engines or cars outside of shops during inclement weather, if shop room and pits are available. This does not apply to work in engine cabs or emergency work on engines or cars set out for or attached to trains. Should it become necessary to establish a regular night shift in shops, such men will not be used on running repair work unless work is brought to shop. When it is necessary to make repairs to engines, boilers, tanks and tank cars, such parts shall be cleaned before mechanics are required to work on same. This will also apply to cars undergoing general repairs. Employees will not be assigned to jobs where they will be exposed to sand blast and paint blowers while in operation. All acetylene or electric welding or cutting will be protected by a suitable screen when its use is required.

Rule 53. Emery wheels and grindstones will be installed at convenient places in the shop and will be kept true and in order.

Help to be Furnished.—Rule 54. Craftsmen and apprentices will be furnished sufficient competent help, when needed to handle the work, if available. When experienced helpers are available, they will be employed in preference to inexperienced men. Laborers when used as helpers will be paid the helpers' rate.

Rule 55. When dismantling or scrapping engines, boilers, tanks, cars (except wood cars) or other machinery, this work will be done by mechanics of their respective crafts. Sufficient help will be furnished. When wood cars are dismantled for scrapping, parts to be removed before car is burned or destroyed will be removed by carmen.

Rule 56. No employee will be required to work under a locomotive or car without being protected by proper signals. Where the nature of the work to be done requires it, locomotives or passenger cars will be placed over a pit, if available.

Rule 57. In shops and roundhouses not now equipped with connections for taking the steam from engines arrangements will be made to equip them so that steam from locomotives will not be blown off inside the house.

Rule 58. All engines will be placed under smoke jacks in roundhouses where practicable, when being fired up.

Rule 59. At shops and roundhouses equipped with electricity, electric light globes and extensions will be kept in tool rooms available for use.

Rule 60. When employees are required to check in and out on their own time, they will be paid one hour extra at the close of each week, regardless of the number of hours worked during the week.

MACHINISTS' SPECIAL RULES

Qualifications.—Rule 61. Any man who has served an apprenticeship or has had four years' experience at the machinists' trade and who, by his skill and experience, is qualified and capable of laying out and fitting together the metal parts of any machine or locomotive, with or without drawings, and competent to do either sizing, shaping, turning, boring, planing, grinding, finishing, or adjusting the metal parts of any machine or locomotive whatsoever shall constitute a machinist.

Classification of Work.—Rule 62. Machinists' work shall consist of laying out, fitting, adjusting, shaping, boring, slotting, milling, and grinding of materials used in building, assembling, maintaining, dismantling, and installing locomotives and engines (operated by steam or other power), pumps, cranes, hoists, elevators, pneumatic and hydraulic tools and machinery, scale building, shafting, and other shop machinery; ratchet and other skilled drilling and roaming; tool and die making, tool grinding and machine grinding, axle truing, axle, wheel and tire turning and boring; engine inspecting; air equipment, lubricator and injector work; removing, replacing, grinding, bolting, and breaking of all joints on superheaters; oxy-acetylene, thermit and electric welding on work generally recognized as machinists' work; the operation of all machines used in such work, including drill presses and bolt threaders using a facing, boring or turning head or milling apparatus, and all other work generally recognized as machinists' work.

Machinist Apprentices.—Rule 63. Include regular and helper apprentices in connection with the work defined by Rule 62.

Machinist Helpers.—Rule 64. Employees assigned to help machinists and apprentices, operators of drill presses and bolt threaders not equipped with a facing, boring or turning head or milling apparatus, bolt pointing and centering machines, wheel presses, bolt threaders, nut tappers and facers; crane men helpers, tool room attendants, machinery oilers, box packers, grease cup fillers and oilers, and applying all couplings between engine and tenders; locomotive tender and draft rigging work except when performed by carmen.

Assignment to Running Repairs.—Rule 65. Machinist assigned to running repairs, shall not be renquired to work on dead work, at points where dead work forces are maintained.

Dead Work.—Rule 66. Dead work means all work on an engine which can not be handled wtihin 24 hours by the regularly assigned running repair forces maintained at point where the question arises.

Dead Work and Running Repair Forces.—Rule 67. Dead work forces will not be assigned to perform running repair work, except when the regularly assigned running repair forces are unable to get engines out in time to prevent delay to train movement.

Work at Wrecks.—Rule 68. In case of wrecks where engines are disabled, machinist and helper (more if necessary) shall accompany the wrecker. They will work under the direction of the wreck foreman.

Apprentices Classification of Work.—Rule 69. Apprentices shall be instructed in all branches of the machinists' trade. They will serve three years on machines and special jobs. Apprentices will not be required to work more than four months on any one machine or special job. During the last year of their apprenticeship they will work on the floor. Apprentices shall not work on oxy-acytylene, thermit, electric or other welding processes until they are in their last year.

Helper Apprentices.—Rule 70. Helpers who have had not less than two consecutive years' experience as machinist helper at the point where employed, at the time application for apprenticeship is made may become a helper apprentice. When assigned as a helper apprentice they must not be over 25 years of age.

Rule 71. Helper apprentices shall serve three years, a minimum of 290 days each calendar year, and shall be governed by the same laws and rules as governed regular apprentices.

Rule 72. The number of helper apprentices must not at any time exceed 50 per cent of the combined number of regular and helper apprentices assigned.

Rule 73. Helper apprentices shall receive the minimum helper rate for the first six months, with an increase of 2 cents per hour for every six months thereafter until they have served three years.

Helpers.—Rule 74. Helpers, when used in any way in connection with machinists' work shall in all cases work under the orders of the machinist, both under the direction of the foremen.

Rule 75. When vacancies occur under classification of machinist helper (temporary or permanent) machinist helpers in the service will be given preference in promotion to position paying either same or higher rate at station employed, seniority to govern.

Rule 76. Laborers, or similar class of workmen, shall not be permitted to do helpers' work as outlined in Rule 64 if regular machinist helpers are available.

Differentials for Machinists.—Rule 77. Machinists required to inspect locomotives and swear to reports required by the Federal Locomotive Inspection Law shall receive 5 cents per hour above the minimum rate paid machinists at the point employed. Autogenous welders shall receive 5 cents per hour above the minimum rate paid machinists at the point employed.

BOILERMAKERS' SPECIAL RULES

Qualifications.—Rule 78. Any man who has served an apprenticeship, or has had four years' experience at the trade, who can with the aid of tools, with or without drawings, and is competent to either lay out, build or repair boilers, tanks and details thereof, and complete same in a mechanical manner shall constitute a boilermaker.

Classification of Work.—Rule 79. Boilermakers' work shall consist of laying out, cutting apart, building or repairing boilers, tanks and drums; inspecting, patching, riveting, chipping, calking, flanging and flue work; building, repairing, removing and applying steel cabs and runnin boards; laying out and fitting up any sheet iron or steel work made of 16 gauge or heavier; (present practice between boilermakers and sheet metal workers on railroads to continue relative to guage of iron), including fronts and doors; grate and grate rigging, ash pans, front end netting and diaphragm work; engine tender steel underframe and steel tender truck frames, except where other mechanics perform this work, removing and applying all staybolts, radials, flexible caps, sleeves, crown bolts, stay rods and braces in boilers, tanks and drums, applying and removing arch pipes; operating punches and shears for shaping and forming, pneumatic stay bolt breakers, air rams and hammers; bull, jam and yoke riveters; boilermakers' work in connection with the building and repairing of steam shovels, derricks, booms, housing, circles and coal buggies; eye beam, channel iron, angle iron and tee iron work; all drilling, cutting and tapping, and operating rolls in connection with boilermakers' work; oxy-acetylene, thermit and electric welding, on work generally recognized as boilermakers' work, and all other work generally recognized as boilermakers' work. It is understood that present practice in the performance of work between boilermakers and carmen will continue.

Boilermaker Apprentices.—Rule 80. Include regular and helper apprentices in connection with the work as defined by Rule 79.

Boilermaker Helpers.—Rule 81. Employees assigned to help boilermakers and their apprentices, operators of drill presses and bolt cutters in the boiler shop, boilerwashers, punch and shear operators (cutting only bar stock and scrap).

Running Repair Work.—Rule 82. Running repair work for boilermakers shall consist of such boilermakers' work as is necessary to fit locomotive to make a successful trip. It shall include staybolt inspection, ordinary repairs to ash pan and front end nettings, calking and repairing leaks in fireboxes and exterior of boiler tanks. The application of staybolts, patches and flues, will be done by dead work forces, but at points where no dead work forces are employed, the roundhouse men will be expected to do such work as will be necessary to fit engine to return to main terminal.

Special Services.—Rule 83. Flange turners, layer outs, and fitter ups

shall be assigned in shops where flue sheets and half side sheets or fireboxes are flanged, removed and applied. One man may perform all these operations where the service does not require more than one man. Boiler inspectors—staybolt inspectors will be assigned at all points where monthly staybolts and boiler inspection of 15 or more engines is required. When such employees have no inspection work to perform, they may be assigned to other boilermakers' work.

Protection for Employees.—Rule 84. Boilermakers, apprentices and helpers will not be required to work on boilers or tanks while electric or other welding processes are in use or when tires are being heated, unless proper protection is provided.

Rule 85. Not more than one oxy-acetylene welding or cutting operator or electric operator will be required to work in firebox or shell of boiler at the same time, unless proper protection is provided.

Rule 86. Oxy-acetylene welding or cutting operator or electric operator will be furnished with helper when necessary or when, in the opinion of the operator, it is essential for personal safety.

Rule 87. Should it become necessary to send oxy-acetylene welder or cutter or electric operator out of the shop in cold weather, he will be given ample time to dry off before being sent out.

Rule 88. When it is necessary to renew, remove or replace flue, door, side or crown sheets, by means of oxy-acetylene or other cutting and welding processes, such portion of the ash pan wings and grates as interfere with the operator, will be removed. Dome caps will be removed and front ends opened up if required, for proper ventilation.

Rule 89. Boilers will have steam blown off and be sufficiently cooled before boilermakers or apprentices are required to work in them; blowers will be furnished when possible to do so. Fireboxes, front ends and ash pans will be properly cleaned out before boilermakers or apprentices are required to work in them. Front ends and fireboxes of engines held in for other than running repairs will be washed out before boilermakers or apprentices are required to work in them. Fire brick interfering with the work to be performed will be removed.

Rule 90. Two boilermakers, or one boilermaker and a competent apprentice with at least two years' experience will be used to operate a long stroke hammer; that is, an air hammer capable of driving staybolts or rivets ⅝ in. diameter or larger, or of expanding flues or tubes. Double gun work will not be permitted. When rolling or expanding superheater flues, two boilermakers, or one boilermaker and a competent apprentice with at least two years' experience, will be used.

Rule 91. No tapping or reaming will be done in fireboxes when same is near enough to endanger the men working on inside of firebox. A space of 10 rows of staybolts will be considered sufficient, it being understood that the helper will protect the men with a sleeve over a tap when tapping is being done.

Furnishing Help.—Rule 92. Boilermakers engaged on running repair work will be furnished a helper when necessary, or when it is essential for personal safety.

Rule 93. Boilermakers sent out on the road to do boilermakers' work will be accompanied by helper, when such work requires a helper at home points.

Removal of Fines.—Rule 64. When flues (other than burst flues) are to be removed, the front end will be opened and such parts of the draft appliances as interfere with the boilermaker will be removed. Center arch pipes in engine, other than those equipped with combustion chambers, which interfere with boilermakers in the performance of their work, will be removed.

Helpers on Flange Fires.—Rule 95. Su..cient competent help will be furnished on flange fires.

Rule 96. Helpers on flange fires will not be asked to go outside of shop to handle fuel during cold weather.

Rule 97. Helpers while engaged on flange fires will not be requested to do other work than that in connection with flanging, and, as far as practicable, regularly assigned men will be used on flange fires.

Helpers—Rule 98. There will be two helpers used in helping a boilermaker or apprentice in breaking down ten or more staybolts with a hand ram.

Rule 99. Classified boilermaker helpers will attend tool room in boiler shop.

Rule 100. Holding on all staybolts and rivets, striking chisel bars, side sets and backing out punches, scaling boilers, and heating rivets (except when performed by apprentices) will be considered boilermaker helpers' work.

Rule 101. When rivets larger than five-eighths inch are to be cut off or backed out, sufficient help will be furnished.

Rule 102. Boilermakers or apprentices, when using compound motors, will be furnished sufficient competent help.

Rule 103. Two helpers will be furnished, when holding on rivets, with wedge bars.

Rule 104. Helpers will do all other work generally recognized as boilermaker helpers' work.

Helper Apprentices.—Rule 105. Fifty per cent of the apprentices may consist of boilermaker helpers who have had not less than two consecutive years' experience as boilermaker helper at the point where employed at the time application for apprenticeship is made. They shall be between the ages of 21 and 40 years and shall serve three years, a minimum of 290 days each calendar year. Helper apprentices shall be governed by the same laws and rules as regular apprentices. Apprentices shall not work on oxy-acetylene, thermit, electric, or other welding processs until they are in their last year. They shall receive the minimum helpers' rate for the first six months, with an increase of two cents per hour for every six months thereafter until they have served their apprenticeship.

Schedule of Work, Regular Apprentices.—Rule 106. The following schedule for regular apprentices showing the division of time on the various classes of work is designed as a guide and will be followed as closely as the conditions will permit.

6 months—heating rivets and helping boilermakers.
6 months—Tank repairing and sheet iron work.
6 months—Rolling flues; ash pan work.
6 months—Staybolts and setting flues.
15 months—General boiler work.
3 months—Electric or oxy-acetylene welding.
6 months—Laying out and flanging.

Rule 107. The following schedule for helper apprentices showing the division of time on the various classes of work is designed as a guide and will be followed as closely as the conditions will permit:

6 months—Tank repairing and sheet iron work.
6 months—Rolling flues; ash pan work.
6 months—Staybolts and setting flues.
9 months—General boiler work.
3 months—Electric or oxy-acetylene welding.
6 months—Laying out and flanging.

Differentials for Boilermakers.—Rule 108. Boilermakers assigned as boiler inspectors, also flangers, layers-out, and autogenous welders shall receive 5 cents per hour above the minimum rate paid boilermakers at the point employed.

Rule 109. Helpers on flange fires shall receive 5 cents per hour above the helpers' rate at point employed.

BLACKSMITHS' SPECIAL RULES

Qualifications.—Rule 110. Any man who has served an apprenticeship, or who has had four years' varied experience at the blacksmiths' trade shall be considered a blacksmith. He must be able to take a piece of work pertaining to his class, and with or without the aid of drawings, bring it to a successful completion within a reasonable length of time.

Classification of Work.—Rule 111. Blacksmiths' work shall consist of welding, forging, heating, shaping, and bending of metal; tool dressing and tempering, spring making, tempering and repairing, potashing, case and bichloride hardening; flue welding under blacksmith foreman; operating furnaces, bulldozers, forging machines, drop-forging machines, bolt machines and Bradley hammers; hammersmiths, drop hammermen, trimmers, rolling mill operators; operating punches and shears doing shaping and forming in connection with blacksmiths' work; oxy-acetylene, thermit and electric welding on work generally recognized as blacksmiths' work, and all other work generally recognized as blacksmiths' work.

Blacksmith Apprentices.—Rule 112. Include regular and helper apprentices in connection with the work as defined by Rule 111.

Blacksmith Helpers.—Rule 113. Employees assigned to helping blacksmiths and apprentices; heaters, hammer operators, machine helpers, drill press and boltcutter operators, punch and shear operators (cutting only bar stock and scrap) in connection with blacksmiths' work.

Helper Apprentices.—Rule 114. Fifty per cent of the apprentices may consist of helpers who have had not less than two consecutive years' experience in shop on the division where advanced. Seniority shall prevail in the selection of helper apprentices; those selected to be not over 30 years of age. Apprentices selected from helpers shall serve three years, a minimum of 290 days each calendar year. When started as an apprentice they shall receive the minimum helpers' rate of pay for the first six months, at the end of that time they shall receive 2 cents per hour increase and 2 cents per hour increase each succeeding six months while serving their apprenticeship. Helper apprentices shall be governed by the same laws and rules as regular apprentices. If after the first three months, they show no aptitude to learn the tradt, they shall be set back to helping and retain their former seniority as a helper. After completing their apprenticeship, they shall receive prevailing rate paid blacksmiths, if retained in the service.

Rule 115. Apprentices shall be given an opportunity to learn all branches of the trade, and will not be kept on any one class of work longer than four months. Apprentices shall not work on oxy-acetylene, electric or other welding processes until they are in their last year.

Rates to be Maintained.—Rule 116. A rate established on a certain class of work shall remain the same and the men placed on such work shall receive such rate.

Helpers Building Fires.—Rule 117. Blacksmith helpers required to prepare furnaces or build fires on their own time will be allowed 30 minutes straight time for each fire built or furnace prepared.

Running Repair Work.—Rule 118. Regularly assigned blacksmiths and helpers engaged on running repair work located at engine houses will work the same hours as other crafts in engine houses.

Furnace operators and Heaters.—Rule 119. Furnace operators (heaters) will be assigned to operate furnaces making or working material 6 in. or over and heating it for foremen. Heaters will be assigned to operate furnaces used in connection with forging machines 4 in. and over, or to heat any material 4 in. and over to be forged. Heaters will also be assigned to heavy fires. When operators are required on other furnaces, helpers will be used.

Rule 120. Coal and oil suitable for smithing purposes will be furnished at all times.

Rule 121. Competent steam hammer drivers will be furnished.

Rule 122. Blacksmiths sent out on the road to do blacksmiths' work will be accompanied by helper.

Rule 123. Helpers will do all other work generally recognized as blacksmith helpers' work.

Differentials for Blacksmiths.—Rule 124. Blacksmiths working or making material 6 in. or over shall be classified as hammersmiths and shall receive 10 cents per hour above the minimum rate paid blacksmiths at the point employed. Blacksmiths working material 4 in. or over, shall be classified as heavy fire blacksmiths and shall receive 5 cents per hour above the minimum rate paid blacksmiths at the point employed. Heaters on heavy fires shall receive 10 cents per hour above the minimum rate paid helpers at point employed. Hammer operators, and helpers working with hammersmiths or heavy fire blacksmiths shall receive 5 cents per hour above the minimum rate paid helpers at the point employed. Furnace operators (heaters) operating furnaces for hammersmiths shall receive the minimum rate paid blacksmiths at the point employed. Autogenous welders shall receive 5 cents per hour above the minimum rate paid blacksmiths at the point employed.

SHEET METAL WORKERS' SPECIAL RULES

Qualifications.—Rule 125. Any man who has served an apprenticeship or has had four or more years' experience at the various branches of the trade, who is qualified and capable of doing sheet metal work or pipe

work as applied to buildings, machinery, locomotives, cars, etc., whether it be tin, sheet iron, or sheet copper, and capable of bending, fitting and brazing pipe, shall constitute a sheet metal worker.

Classification of Work.—Rule 126. Sheet metal workers shall include tinners, coppersmiths and pipe fitters employed in shop yards and buildings and on passenger coaches and engines of all kinds, skilled in the building, erecting, assembling, installing, dismantling, and maintaining parts made of sheet copper, brass, tin, zinc, white metal, lead, black, planished, pickled and galvanized iron of 10 gage and lighter (present practice between sheet metal workers and boilermakers on railroad to continue relative to gage of iron), including brazing, soldering, tinning, loading and babbitting; the bending, fitting, cutting, threading, brazing; connecting and disconnecting of air, water, gas, oil and steam pipes; the operation of babbitt fires and pipe-threading machines; oxy-acetylene, thermit and electric welding on work recognized as sheet metal workers' work, and all other work generally recognized as sheet metal workers' work.

Sheet Metal Worker Apprentices.—Rule 127. Include regular and helper apprentices in connection with the work as defined by Rule 126.

Sheet Metal Worker Helpers.—Rule 128. Employees regularly assigned as helpers to assist sheet metal workers and apprenticcs in their various classifications of work.

Rule 129 Sheet metal workers shall not be required to remove or apply blow-off or surface pipes or ash-pan blowers on boilers under steam

Rule 130. Sheet metal workers will be sent out on line of road and to outlying points, when their services are required, but not for small, unimportant running repair jobs.

Assignment or Running Repair Force to Dead Work.—Rule 131. The assignment of running repairs sheet metal workers to dead work shall not be the recognized practice; but at points where no dead work sheet metal workers are employed, they may be so assigned if the service requires it.

Assignment of Dead Work Force to Running Repairs.—Rule 132. Dead work forces will not be assigned to perform running repair work, except when the regularly assigned running repair forces are unable to get engines out in time to prevent delay to train movement.

Rule 133. Sheet metal workers will not be assigned to work not applicable to them, except in emergency cases.

Helper Apprentices.—Rule 134. Fifty per cent of the apprentices may be selected from helpers of this craft who have had not less than two consecutive years' experience as a sheet metal worker helper at the point where employed, and shall not be more than 30 years of age; such apprentice shall serve three calendar years, a minimum of 290 days each calendar year, seniority to govern.

Rule 135. Helper apprentices will start at the third classification of regular apprentices' schedule when entering their apprenticeship, and continue through as regular apprentices. Helper apprentices will receive the minimum helpers' rate for the first six months, with an increase of 2 cents per hour for every six months thereafter until they have served three years.

Rule 136. Laborers, or similar class of workmen, shall not be permitted to do helpers' work as outlined in Rule 128 if regular sheet metal workers' helpers are available.

Rule 137. Regular apprentices' schedule and division of time:

6 months—Helping.
6 months—Light pipe work.
12 months—Tinning, babbitting and brazing, laying out and forming.
12 months—Engine and car work.
12 months—General work, including one month's experience with the oxy-acetylene torch.

Differentials for Sheet Metal Workers.—Rule 138. Autogenous welders shall receive 5 cents per hour above the minimum rate paid sheet metal workers at point employed.

ELECTRICAL WORKERS' SPECIAL RULES

Qualifications.—Rule 139. Any man who has served an apprenticeship or who has had four years' practical experience in electrical work and is competent to execute same to a successful conclusion will be rated as an electrical worker. An electrician will not necessarily be an armature winder.

Classification of Electricians.—Rule 140. Electricians' work shall consists of repairing, rebuilding, installing, inspecting and maintaining the electric wiring of generators, switchboards, motors and control, rheostats and control, static and rotary transformers, motor generators, electric headlights and headlight generators, electric welding machines, storage batteries, and axle lighting equipment; winding armatures, fields, magnet coils, rotors, transformers, and starting compensators. Inside wiring in shops and on steam and electric locomotives, passenger train and motor cars; include cable splicers, wiremen, armature winders, electric crane operators for cranes of 40 ton capacity or over, and all other work properly recognized as electricians' work.

Classification of Linemen, Etc.—Rule 141. Linemen's work shall consist of building, repairing and maintaining pole lines and supports for service wires and cables, catenary and monorail conductors and feed wires, overhead and underground and all outside wiring in yards. Men employed as motor attendants, generator attendants and substation attendants who start, stop and oil and keep their equipment clean and change and adjust brushes for the proper running of their equipment, switchboard operators, coal in connection with loading and unloading vessels. Electric crane operators for cranes of less than 40-ton capacity.

Rule 142. Groundmen's work shall consist of assisting linemen in their duties when said work is performed on the ground.

Rule 143. Coal pier elevator operators and coal pier electric hoist operators in connection with loading and unloading vessels.

Apprentices Electrical Workers.—Rule 144. Include regular and helper apprentices in connection with electrical workers.

Electrical Worker Helpers.—Rule 145. Employees regularly assigned as helpers to assist electrical workers and apprentices, including electric lamp trimmers who do no mechanical work.

Rule 146. Fifty per cent of the apprentices may consist of electrical workers' helpers who have had two years continuous service at the point where employed. When assigned as helper apprentices, they must not be over 25 years of age, and shall serve three years, a minimum of 290 days each calendar year.

Rule 147. The following schedule for regular apprentices, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as possible:

12 months—Inside wiring and electrical repairing.
6 months—Outside line work.
6 months—Locomotive headlight work.
6 months—Car lighting department.
6 months—Armature winding.
12 months—General electrical work.

Rule 148. Helper apprentices will receive the minimum helpers' rate for the first six months, with an increase of two cents per hour for every six months thereafter until their apprenticeship is completed. If within six months they show no ability to acquire the trade, they will be set back to helping and retain their former seniority as a helper. After completing their apprenticeship they shall receive the minimum rate paid for the work to which they are assigned, if retained in the service.

Rule 149. The following schedule for helper apprentice showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as possible:

6 months—Inside wiring and electrical repairing.
6 months—Outside line work.
6 months—Locomotive headlight work.
6 months—Car lighting department.
6 months—Armature winding.
6 months—General electrical work.

Rule 150. Laborers or similar class of workmen shall not be permitted to do helpers' work as outlined in Rule 145 if regular electrical worker helpers are available.

Rule 151. Men engaged in the handling of storage batteries and mixing acid must be provided with acid-proof rubber gloves, hip boots and aprons.

Rule 152. Autogenous welders shall receive 5 cents per hour above the minimum rate paid electrical workers at point employed.

CARMEN'S SPECIAL RULES

Qualifications.—Rule 153. Any man who has served an apprenticeship or who has had four years' practical experience at car work, and who with the aid of tools, with or without drawings, can lay out, build or perform the work of his craft or occupation in a mechanical manner, shall constitute a carman.

Classification of Work.—Rule 154. Carmen's work shall consist of building, maintaining, dismantling, painting, upholstering and inspecting all passenger and freight cars, both wood and steel, planing mill, cabinet and bench carpenter work, pattern and flask making, and all other carpenter work in shop and yards; carmen's work in building and repairing motor cars, lever cars, hand cars and station trucks; building, repairing and removing and applying locomotive cabs, pilots, pilot beams, running boards, foot and headlight boards, tender frames and trucks; pipe and inspection work in connection with air brake equipment on freight cars; applying patented metal roofing; repairing steam heat hose for locomotives and cars; operating punches and shears doing shaping and forming, hand forges and heating torches in connection with carmen's work; painting, varnishing, surfacing, lettering, decorating, cutting of stencils, and removing paint; all other work generally recognized as painters' work, under the supervision of the locomotive and car departments; joint car inspectors, car inspectors, safety appliance and train car repairers, wrecking derrick engineers, and wheel record keepers; oxy-acetylene, thermit and electric welding on work generally recognized as carmen's work, and all other work generally recognized as carmen's work. It is understood that present practice in the performance of work between the carmen and boilermakers will continue.

Carmen Apprentices.—Rule 155. Include regular and helper apprentices in connection with the work as defined by Rule 154.

Carmen Helpers.—Rule 156. Employees regularly assigned to help carmen and apprentices, employees engaged in washing and scrubbing the inside and outside of passenger coaches, preparatory to painting, car oilers and packers, stock keepers (Car Department). Material carriers, rivet heaters (except when performed by apprentices), operators of bolt threaders, nut tappers, drill presses and punch and shear operators (cutting only bar stock and scrap), holding on rivets, striking chisel bars, side sets and backing out punches, using backing hammer and sledges in assisting carmen in straightening metal parts of cars, cleaning journals, assist carmen in erecting scaffolds and all other work generally recognized as carmen helper's work.

Wrecking Crews.—Rule 157. Wrecking crews, including engineers and firemen shall be composed of regularly assigned carmen, and will be paid for such service as per General Rules from time called until return to their home station. Meals and lodging will be provided by the company while crews are on duty in wrecking service.

Rule 158. When wrecking crews are called for wrecks or derailments outside of yard limits, the regularly assigned crew will accompany outfit. For wrecks or derailments within yard limits, sufficient carmen will be called to perform the work.

Inspectors.—Rule 159. Men assigned to inspecting must be able to speak and write the English language, and have a fair knowledge of the M. C. B. rules and safety appliance laws.

Rule 160. Inspectors and other carmen in train yards will not be required to take record, for conducting transportation purposes, of seals, commodities, or destination or cars.

Safety Appliance Men.—Rule 161. Men assigned to follow inspectors in yards to make safety appliance and light running repairs, shall not be required to work on cars taken from trains to repair tracks.

Protection for Repairmen.—Rule 162. Switches of repair tracks will be kept locked with special locks, and men working on such tracks shall be notified before any switching is done. A competent person will be regularly assigned to perform this duty and held responsible for seeing it is performed properly.

Rule 163. Trains or cars while being inspected or worked on by train

yard men will be protected by blue flag by day and blue light by night, which will not be removed except by men who place same.

One Man Points.—Rule 164. A "one main point" is an outlying point where there is employed one carman, day, and one, night, or where there is only one carman employed. Carmen stationed at one man points shall be paid by the hour and under the rules governing running repair forces, except that the eight hours constituting a day's work may be worked within a spread of ten consecutive hours.

Rule 165. Air hammers, jacks and all other power driven machinery and tools, operated by carmen or their apprentices will be furnished by the company and maintained in safe working condition.

Rule 166. Crayons, soapstone, marking pencils, tool handles, saw-files, motor bits, brace bits, cold chisels, bars, steel wrenches, steel sledges, hammers (not claw-hammers), reamers, drills, taps, dies, lettering and striping pencils and brushes will be furnished by the company.

Rule 167. The application of blacking to fireboxes and smoke boxes of locomotives, in roundhouses, will not be considered painters' work.

Rule 168. When necessary to repair or inspect cars on the road or away from the shops, carmen will be sent out to perform such work. Two carmen will be sent to perform such work as putting in couplers, draft rods, draft timbers, arch bars, center pins, putting cars on center, truss rods and wheels, and work of similar character.

Rule 169. Shops, repair yards and train yards where carmen are employed shall be kept clean of all rubbish.

Apprentices.—Rule 170. Regular apprenticeships will be established in all branches of the trade. Apprentices shall be governed by the general rules covering apprentices.

Rule 171. Apprentices shall not work on oxy-acetylene, thermit, electric or other welding processes until they are in their last year.

Helper Apprentices.—Rule 172. Fifty per cent of the apprentices may be selected from carmen's helpers who have had not less than two consecutive years' experience at the point employed, at the time application for apprenticeship is made. Helper apprentices shall not be over thirty years of age and will serve three years, a minimum of 290 days each calendar year. Helper apprentices shall be governed by the same laws and rules as regular apprentices. Helper apprentices shall receive the minimum helpers' rate for the first six months, with an increase of two cents per hour each succeeding six months until they have served three years. At the completion of their apprenticeship eriod, if retained in the service, they shall receive the mechanic's rate of pay.

Painter Apprentices, Regular.—Rule 173. Regular apprentices—Division of time for painter apprentices.

The following schedule for regular aprentices, painter, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as the conditions will permit:

6 months—Freight car painting.
6 months—Color room, mixing paint.
6 months—General locomotive painting.
12 months—Brush work, passenger equipment.
18 months—Lettering, striping, varnishing, and such laying-out and designing as the shop affords.

Schedule of Work, Painter Helper Apprentices.—Rule 174. Helper apprentices, division of time for painter apprentices. The following schedule for heler apprentices, painter, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as the conditions will permit:

4 months—Freight car painting,
4 months—Color room, mixing paint,
4 months—General locomotive painting,
10 months—Brush work, passenger equipment,
14 months—Lettering, striping, varnishing, and such laying-out and designing as the shop affords.

Regular Apprentices Carmen Schedule of Work.—Rule 175. The following schedule for regular apprentices, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as the conditions will permit. Where sufficient passenger car department work is not available without exceeding the regular ratio of apprentices, in the passenger car department, apprentices will complete their apprenticeship in the freight car department.

18 months—General freight work, wood and steel.
6 months—Air brake work.
6 months—Mill machine work.
18 months—General coach work, wood and steel.

Helper Apprentice Carmen Schedule of Work.—Rule 176. The following schedule for helper apprentices, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as the conditions will permit. Where sufficient passenger car department work is not available without exceeding the regular ratio of apprentices, in the passenger car department, apprentices will complete their apprenticeship in the freight car department.

12 months—General freight work, wood and steel.
6 months—Air brake work.
6 months—Mill machine work.
12 months—General coach work, wood and steel,

Rule 177. In the event of not being able to employ carmen with four years' experience and the regular and helper apprentice schedule not providing men enough to do the work, the force may be increased in the following manner: Regular apprentices who have served two years and helper apprentices who have served two years, may be promoted to mechanics at point employed and will be paid the minimum rate for carmen, seniority to govern. Helpers who have had four or more years' experience at point empolyed, may be promoted to mechanics, they to receive the minimum rate for carmen and be given an opportunity to learn the trade, seniority to govern. The duly authorized committee in each shop covered by this agreement will be consulted and mutual understanding arrived at in promoting helpers. The ratio of helpers to be promoted, to the number of mechanics in any one shop shall not exceed twenty per cent. The general chairman on each railroad affected shall be furnished a complete record of the men promoted. When a reduction is made in force of mechanics, promoted helpers in accordance with their seniority shall be set back first; then advanced apprentices. No mechanics to be laid off until all such promoted helpers and apprentices have been set back. Promoted apprentices and promoted helpers who have not served four years as mechanics, will be set back at any time that mechanics with four or more years' experience make application for employment.

Differentials for Carmen.—Rule 178. Autogenous welders shall receive 5 cents per hour above the minimum rate paid carmen at point employed.

Differentials for Coach Cleaners.—Rule 179. For coach cleaners establish basic minimum rate of 41 cents per hour and to this rate and all rates above 41 cents per hour add 4 cents making a minimum of 45 cents. Coach cleaners to be included in the national agreement and will receive overtime as provided therein.

MISCELLANEOUS

Scope of General and Special Rules.—Rule 180. Except as provided for under the special rules of each craft, the general rules shall govern in all cases.

Effect on Existing Agreements.—Rule 181. In consideration of the standardization of hours of service and rules governing working conditions hereby established on all railroads in Federal operation, the general and special rules of this agreement shall supersede and be substituted for the general and special rules of existing agreements in conflict herewith; rules of existing agreements dealing with conditions of employment not specifically provided for herein shall remain in effect and be recognized as addenda to this agreement by the several railroads who negotiated such rules. Rulings that have been made by the Director General of Railroads and Railroad Board of Adjustment No. 2, where not in conflict with the rules of this agreement, shall remain in effect.

Duration of Agreement.—Rule 182. These general and special rules and regulations shall remain in full force and effect during federal operation unless superseded or amended as herein provided. They shall be printed by the railroads and each employe affected thereby shall be provided with a copy on request.

Revision of Agreement, Etc.—Rule 183. Should either the Railroad Administration or the organizations desire to revise these rules, a written statement containing the proposed changes shall be given and conference held within thirty days to arrange details necessary to negotiate to a conclusion.

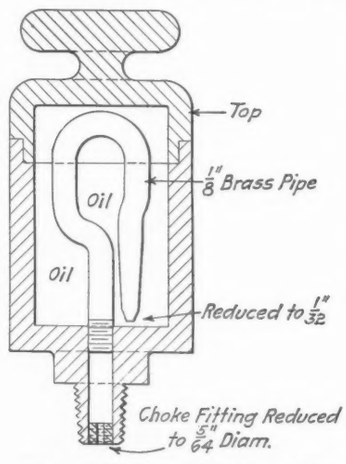
Rule 184. Except as herein provided, nothing in these rules shall be construed to supersede methods of procedure promulgated by the Railroad Administration for the handling of grievances, or the application or interpretation of the provision of this agreement.

Rule 185. This agreement shall become effective 30 days after date signed by the Director General of Railroads, and the representatives of the employees' organizations.

Rule 186. Differentials provided for in this agreement for highly skilled employees shall become effective as of May 1, 1919.

SIMPLEX OIL CUP

An oil cup designed especially for use on the high pressure air cylinder of the cross-compound type of air pump is shown in the drawing. This cup consists of a cylindrical brass casting made in two parts, with a 1/8-in. brass pipe inserted as shown. The pipe is threaded at one end and screwed into the bottom of the brass cup, and the other end is reduced to 7/32-in. oil intake. A choke fitting 5/64 in.



Cross Section of Simplex Oil Cup

in diameter is fitted into the outlet, thus preventing the cylinder from being flooded with oil. These cups require no regulating as they operate only while the air pumps are running, and as the feed is regular and the amount of oil only sufficient to meet the requirement of the pump, they are very economical.

In the cup illustrated old choke plugs from bull's-eye lubricators were used. As will be seen from the drawing,

the oil syphons over the bend in the feed pipe, by this means feeding the oil in regular quantities when the pumps are in operation.

THE COST OF BRITISH LOCOMOTIVES

BY ROBERT E. THAYER

European Editor of the *Railway Mechanical Engineer*

Our London contemporary, the Railway Gazette, in a recent editorial criticizes the Egyptian State Railway Administration for spending several thousand pounds for locomotives in America, indicating that the purchases were made without due consideration of prices even though the British concerns quoted prices from 76 per cent to 81 per cent higher than that quoted by the successful American locomotive builder. Its implication was, although they took great pains to forestall any criticism in this respect, that even though the quotations of the British manufacturers were much higher than those of the American manufacturer "the quality of British workmanship and the class of material put into the engines, compared with those produced in other countries, result in an economy in repairs and maintenance and an increased life which more than repay the higher first cost."

The figures quoted as the bids of the British manufacturers were from £15,000 ($63,000)* to £17,000 ($71,400)* with a possible delivery in 1921, as against the American locomotive builder's figures of £8,500 ($35,000)* to £9,400 ($39,500)* with delivery in four months. In other words the Railway Gazette would imply that the workmanship of the British locomotive builders is sufficiently better to warrant the Egyptian State railways paying from $27,000 (76 per cent) to $32,000 (81 per cent) more a piece for their locomotives! We are well aware that the expense of maintenance and repairs should be as carefully considered as the first cost of an article, but at the same time we also believe that the interest on the investment is as important a factor as the cost of maintenance. Figuring money at five per cent, which is an exceedingly conservative rate at the present time, had the Egyptian State Railways purchased their locomotives from the British manufacturers at the quoted figures they would have had additional yearly capital charges varying from $1,400 to $1,600 to apply to each one of these engines.

Before the war, the manufacturers in Great Britain were in a particularly advantageous position as regards the cost of labor. They could economically put more labor in their manufactured articles and produce a product of greater refinement at a much lower cost than was possible in the United States. At the same time the low cost of labor made unnecessary the development and use of the so-called labor saving machinery. During and since the war, however, the cost of labor has increased in Great Britain to such an extent that the cost of the final product when made according to pre-war practice, is greatly increased. America, on the other hand, having had to carefully watch its labor cost has constantly improved its manufacturing methods by the installation of improved machinery, and on the other hand, found it impractical and uneconomical, in the final analysis, to go to the refinement of the British manufacturers.

The real lesson to be learned from the fact that the colonies of Great Britain can buy so much cheaper from America is that greater development has been made in America in the use of improved machinery. It has been repeatedly stated by careful students in manufacturing costs that with the greatly increased cost of labor, both Great Britain and many of the European countries will find it increasingly necessary to improve their manufacturing methods and to use more modern labor saving machinery than they have in the past.

*Based on an exchange rate of $4.20.

RAILROAD ADMINISTRATION NEWS

The Railroad Administration, according to a statement authorized by Director General Hines on November 15, has proposed to the four brotherhoods representing the train and engine employees that in order to give an additional measure of compensation to the employees in the slow freight service, time and one-half will be paid for time required to make their runs in excess of what would be required if an average speed of 12½ miles per hour were maintained, provided, however, that all arbitraries and special allowances now paid in various forms of freight train service are entirely eliminated. The proposal was taken under consideration by the officials of the brotherhoods that have been conferring with Mr. Hines and Railroad Administration officials, with a view to consideration and further discussion. The statement says it is estimated that the net cost of this proposal will be approximately $3,000,000 a month, or $36,000,000 a year.

VOCATIONAL EDUCATION FOR MECHANICS AND APPRENTICES IN RAILROAD SHOPS

For the guidance of railroads contemplating the establishment of schools and classes for training of mechanics and apprentices under provisions of the federal vocational education act and the Division of Operation circular of August 1, 1919, the following additional information on the matter is submitted in a circular issued by Frank McManamy, assistant director of the division:

The federal vocational education act provides that schools organized under its provisions shall be conducted by the particular state in which the school or class may be located, and under the general direction of the state board for vocational education.

It is expressly stated in the act that the controlling purpose of the work to be aided under its provisions is to fit for useful employment those who are preparing for a trade or industrial pursuit or who have entered upon the work of a trade or industrial pursuit.

The purpose for which federal money has been appropriated and may be expended by the state and under what conditions the state may allot such funds is determined in general by the provisions of the law, all details of which will be furnished upon application to the state board for vocational education.

The general conditions for the conduct of the schools set up in the act are as follows:

1. The school or class must be under public supervision or control.
2. The controlling purpose must be to prepare for useful employment.
3. The instruction given in the schools must be of less than college grade.
4. All pupils must be over 14 years of age.
5. To meet the requirements of the vocational education act, the instruction must be given for not less than 144 hours per year. The United States Railroad Administration authorization for 208 hours of instruction per year meets this condition.
6. Every dollar of federal funds must be matched by a dollar of state or local money, or both. The expenditures are to be made by the state board or by the local community, and reimbursement made from federal funds by the state board for vocational education.
7. Reimbursements may be made from federal funds only for money expended for salaries of teachers. This does not include any reimbursement for buildings, equipment, or supplies.
8. The railroad must supply the plant and equipment adequate for the type of instruction to be given. This has

already been authorized by the Railroad Administration in circular issued August 1, 1919.

9. The course of study may include trade drawing, trade science, trade mathematics, and actual shop work. In all cases the instruction given shall be of the trade-extension type, supplementing in character the regular employment of the pupil.

10. The methods of instruction must be such as will insure the functioning of that instruction in the trade which the apprentice is learning. This means that the instruction should be given as far as possible by the individual method rather than through lectures. Demonstrations, illustrations, and examples should be drawn from the shop in which the pupil is employed. A careful coordination must be maintained between the instructor responsible for the related instruction in the classroom and the training which the apprentice is receiving in the shop.

11. All instructors for whose work reimbursement is to be made through the state board for vocational education must be thoroughly qualified and meet the qualifications set up by the state plan in the state in which the work is to be given. The instructor of related subjects should be a man possessing at least two years' technical education of college grade, or equivalent technical education, and having a satisfactory practical experience and contact in one or more of the trades represented in the railroad shop—a contact giving an appreciation and working knowledge of the principal trade processes. It is recognized that whenever a man can be found possessing, in addition to the technical training, a journeyman's experience in a trade, he is more likely to be successful as an instructor.

The Federal Board for Vocational Education, in cooperation with the United States Railroad Administration, will prepare suggested courses of study for at least three trades, namely, machine shop, boiler making, and sheet-metal work, and these suggested courses of study will be placed at the disposal of the various state boards, and through these boards can be obtained by the railroads upon application.

There are certain conditions which should be considered in making arrangements for railroad shop apprentices' schools under this plan:

1. There should be an advisory committee. Such committee may properly include representatives of the workers in the trades, the shop management, and public school.

2. This advisory committee should be responsible for insuring cooperation between the workers, shop management and public-school authorities.

3. The instructors employed for this work should be satisfactory to the advisory committee, as well as meeting the qualifications set up in the state plans.

4. The courses of study should be satisfactory to this advisory committee.

5. The classrooms to be used should be suitably fitted up for the instruction which is to be given, and they should be so located that the apprentices may readily have access from the shop to the classroom and the classroom to the shop without the necessity of making an entire change of clothing or entailing an unnecessary loss of time.

It is understood that railroads may conduct their own schools independent of these arrangements with the Federal Board for Vocational Education, but in such cases the entire expense will be borne by the railroad, and no reimbursement can be made from federal funds under provisions of the federal vocational education act.

ORDERS OF REGIONAL DIRECTORS

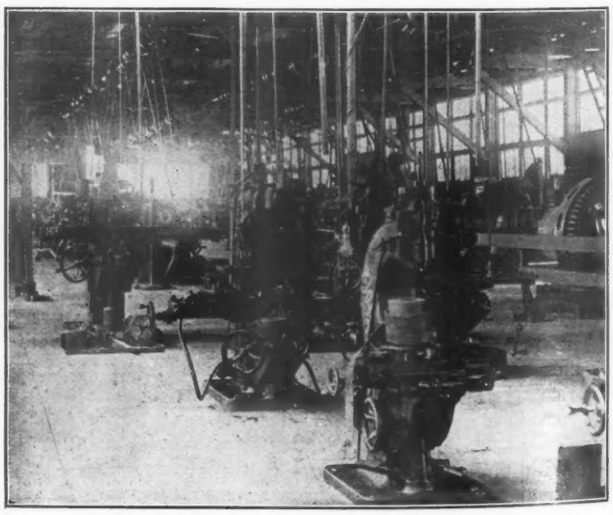
Condition of Locomotive Cabs.—The Northwestern regional director, file 66-1-122, states that the condition of many locomotive cabs is such that in cold weather severe hardships to the men as well as loss of efficiency will result. Openings in cabs around boilerheads, injector pipes, reverse levers and other places must be properly closed; clear vision windows must open and close properly; cab heaters must be applied and be put in proper condition for service, and suitable cab curtains must be provided as soon as needed.

Curtailment of Passenger Service.—The Railroad Administration has made drastic reductions in passenger service in all sections of the country in order to meet the threatened shortage of fuel due to decreased production of coal, which has fallen to less than 50 per cent of normal following the strike of bituminous miners. In the west one-third of the trains were discontinued, in New England 10 per cent were taken off and in the Eastern region practically the same reductions made during the war were again put into effect. The orders in some cases were even more drastic than the wartime restrictions. The Twentieth Century Limited, which had run all during the war was ordered discontinued after December 9.

The order limiting the number of trains in the Northwestern, Central Western and South western regions was issued by P. S. Eustis, chairman of the Western Passenger Committee. It called for the elimination of passenger trains which could be spared with the least inconvenience to the traveling public and the discontinuance of all parlor, club and lounge cars and the elimination of all special trains.

The order reducing the number of trains on the eastern roads was issued on December 5 by A. T. Hardin, regional director of the Eastern region and read in part as follows: "For the purpose of conserving fuel and to protect and provide sufficient transportation, an order has been given for a reduction in train service, effective 12:01 a.m., December 10, on all railroads in the Eastern region. This is necessary not only to conserve fuel, but also to afford the freest facility for expeditious movement of fuel where there may be acute shortages.

"The reduction in service will be general on all roads and will be made so far as practicable on the several lines having common termini, to support each other and afford the maximum service with the minimum number of trains and the least inconvenience to the traveling public. No special trains are to be run for pleasure travel; no second sections of regular trains will be operated except in cases of coach travel to and from cities of dense population, and then only when absolutely indispensable."



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U. S. Army Machine Shop at Gievres, France, Included in the $300,000,000 Sale of Army Supplies to the French Government

STEEL FIREBOXES IN EUROPEAN LOCOMOTIVES

BY W. G. LANDON

Steel fireboxes have not been popular in Europe and in the absence of any other explanation, the treatment the firebox gets in service—in other words, the methods of firing and boiler feeding—may account for this.

Abroad the old fashioned flat ash pan is universal and it is fitted with one or two dampers, which effectually exclude all air when they are closed. The lever controlling the damper is matched, thus permitting a graduated opening. The grates are usually of the fixed pattern. On the Continent shaking grates are used to a small extent but they are so arranged that they do not rock far enough to shake down the fire. Short brick arches are always installed, but arch tubes are not used. The smokebox contains no deflector plate or other arrangement for equalizing draft. Sometimes a netting is arranged around the petticost pipe.

In England boiler feeding is done uniformly on long runs, the injector being left on continuously as in America. Firing intervals are, however, much longer, three to five minutes or more. The practice is to put 10 to 15 shovelsful to a fire and as the grate areas are only 20 to 25 sq. ft., the cooling effect on the firebox must be considerable. All locomotives are supplied with lump coal, which makes this kind of firing possible. Usually the damper is partly closed and a considerable amount of air admitted through the firedoor. The firedoor opens inward on the locomotives of many English railways. In cases where it does not a deflector plate is used, thus driving the incoming air down on the fire. As the fire gets dirty, the damper is opened up and the firedoor closed if necessary. At the running shed or roundhouse, the fire is dumped by knocking out a few grate bars, and the smokebox door is opened and the cinders cleared out. In firing up, natural draft is used and, of course, if the boiler is cool d temperature difference in great is set up between the upper and lower portions of the firebox. Washing out is generally done with cold water, although a few hot water systems have been installed.

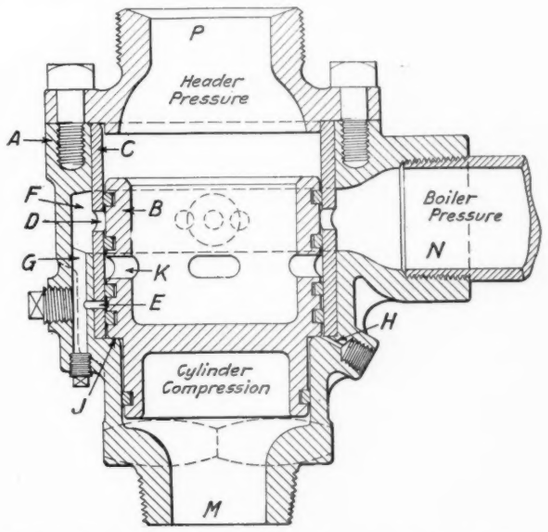
In France the methods are the same, except that injectors are usually over size, so that it is impossible to cut down the feed fine enough for continuous feeding. There is an exception to this—the Paris, Lyons & Mediterranean Railway. Both injectors of these locomotives are on the fireman's side and one is of the proper size for continuous pumping. The idea of the over-size injector originated many years ago, when French engines were supplied with lump coal. Just before firing, the injector was shut off and a large fire put in. Thus the cooling effect of the feedwater would be arrested while the cold air was entering through the firedoor. After the door was closed, the injector was again put on for four or five minutes until firing was again necessary. Now, however, the engines are supplied with coals having a large proportion of slack, so the firing intervals have to be shorter. Consequently the injector is left on for the same length of time, while the firing intervals are reduced to one or two minutes. The slack is wetted down copiously, forming a mush, and siz or seven shovels of this cause a considerable drop in firebox temperature, which together with the excessive amount of feedwater entering the boiler, must cool the lower flues and firebox more than is desirable. The theory of drenching the coal is that although heat is used in evaporating the water, the fusible part of the coal will run and bind the small particles before they are light enough to be lifted from the fire bed, and that the steam escaping from the wet slack forms air passages which assist in combustion. While this theory may have some basis the smokebox of an engine which has been worked on a long run is often nearly half filled with cinders and consequently a large number of the lower flues are plugged up. The firedoor is not left open while running, the draft being controlled by the variable exhaust.

At the roundhouse the fire is cleaned with a variety of implements carried on each engine, the good fire being pulled to the back and covered over, and the clinkers pushed forward. Before the crew leaves the engine, both injectors are frequently put on, thus filling the boiler at a very rapid rate when the fire is practically dead. When the fire is made up the clinkers are pushed out through a dump grate at the front of the firebox.

These practices may be followed occasionally without apparent injury to the boiler, but when they are persisted in the effect must be evident and it would seem that if steel firebox are to be introduced in Europe, some active propaganda on boiler treatment must be conducted.

RIPKEN AUTOMATIC DRIFTING VALVE FOR LOCOMOTIVES

Since superheated steam has come into general use the trouble experienced with deposits on locomotive pistons and cylinders has increased greatly. The use of the drifting throttle has proved effective in eliminating this trouble, but it is difficult to insure that the engineer uses the proper amount of steam and for that reason an automatic drifting valve has important advantages over the drifting throttle. Several types of drifting valves are in use at present, the majority being arranged to come into action when a vacuum is formed in the cylinder. Since the vacuum which operates the valve will also draw in the front end gases which cause



Section Showing the Construction of the Ripken Automatic Drifting Valve

deposits on the cylinder walls, any drifting valve operated on this principle cannot entirely remove the trouble.

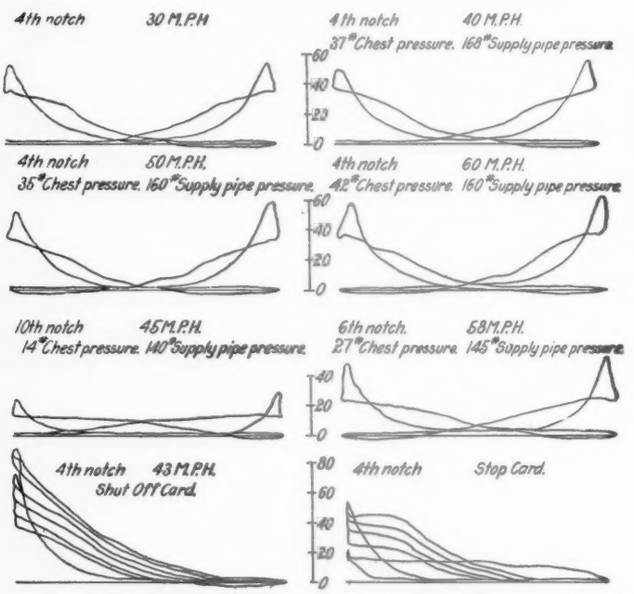
In order to do away with the formation of a vacuum in the cylinder a valve has been devised which is operated by the compression in the cylinder. This device is known as the Ripken automatic drifting valve and is in use on the Minneapolis, St. Paul & Sault Ste. Marie. The valve comes into operation before the cylinders are emptied of steam pressure after the throttle has been closed and is kept in operation and furnishes the needed amount of steam until the pistons cease to move. It is automatically closed just as the engine stops by the building up of pressure in the steam chest.

Only one valve per engine is used as the steam is passed

directly to the branch pipe or the saturated end of the superheater header. This arrangement is advantageous as it reduces the amount of steam required and also protects the superheater elements against overheating. It is unnecessary to use either air relief valves or by-pass valves in conjunction with the Ripken drifting valve.

The illustration below shows a section of the valve which serves to illustrate its operation. The operating portion consists of a cage *A*, and a differential piston valve *B*. The cage has an opening *M*, at the bottom which is connected by the most direct means possible with one end of the cylinder so that the cylinder pressure is transmitted to the lower side of the piston. The side opening *N* is connected through a two-inch pipe to a live steam line from the turret. The opening *P* at the top of the valve communicates with the branch pipe or superheater header.

Within cage *A* is a bushing *C*, in which are ports *D* and *E*. The port *D* is surrounded by a duct *F*, which is always filled with live steam. From duct *F* live steam passes through the passage *G* to port *E*. At the lower end of the bushing *C* is a small regulating and relief port *H*,



Typical Indicator Cards from an Engine Equipped with the Ripken Drifting Valve

connected by piping to the exhaust chamber of the locomotive.

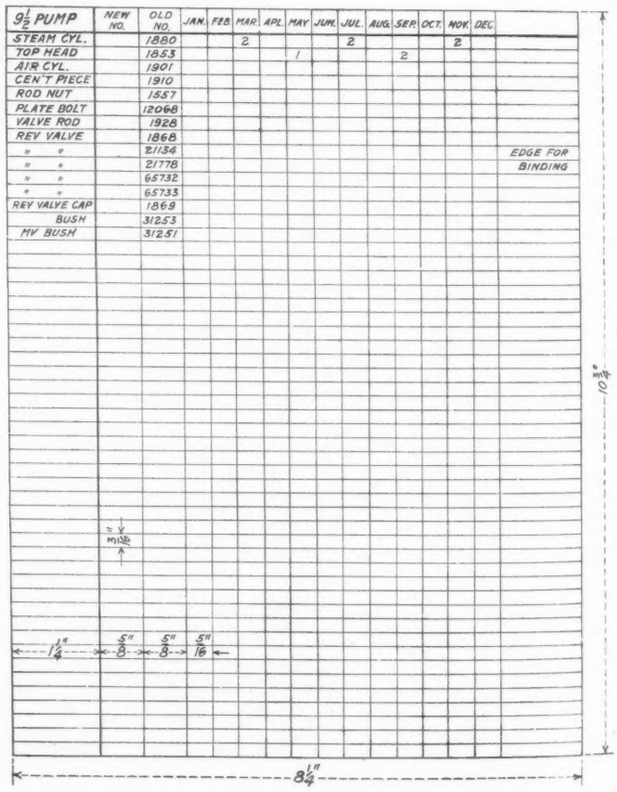
When the main throttle is closed the pressure on top of the differential piston *B* falls and the compression in the cylinders acting on the bottom of the valve being in excess of the steam chest pressure raises the valve *B* off the shoulder *J*, upon which it normally rests, placing the port *K* in communication with port *D*. This permits steam to flow through the valve into the steam chest maintaining the required pressure to prevent a vacuum while drifting. The raising of the valve also uncovers port *E* and the steam entering the annular cavity under the valve is restricted by the port *H* and furnishes the counter pressure necessary to hold ports *D* and *K* in communication until the engine is almost at a standstill. As the speed decreases the pressure in the steam chest will rise, and overcoming the pressure on the bottom of the differential valve, will force the valve to its seat, where the friction of the rings will hold it closed. Any slight leakage past the lower rings is taken care of by the port *H* and it is, therefore, practically impossible for the valve to open while the engine is at rest.

Tests on a superheater locomotive with 25 in. by 26 in. cylinders supplied with steam from a two-inch pipe showed that the valve when adjusted to close at about 40 lb. per sq. in. would maintain between 25 and 30 lb. pressure in the steam chest at 25 per cent cutoff at a speed of 60 miles an hour, preventing the formation of a harmful vacuum even at such high speed. After a shut-off with the reverse lever in running position, the valve would open when the steam chest pressure dropped to about 30 lb. The valve would close again when the steam chest pressure arose to 40 lb. which occurred just before the stop, allowing time for the superheater to empty itself before the engine came to rest. The Ripken drifting valve has been in use nearly two years with excellent results. It has required little attention and has prolonged the life of both the cylinder and the piston rod packing on the engines to which it has been applied.

A CONVENIENT RECORD FOR AIR BRAKE MATERIAL

BY J. A. JESSON

The Westinghouse Air Brake Company's part catalogues are issued in numerical order, and each shop is usually furnished with a complete set in a loose leaf binder. Each sheet illustrates one unit with its accessories, and gives a list of the parts and the numbers of the items. In order to render this catalogue more serviceable it has been our practice



Stock Sheet Used in Connection with Air Brake Part Catalogue

for some time to insert an extra sheet for each separate device. This covers in an abbreviated form the items which are ordered, and has columns for the name, the old and new piece number, and a separate column for each month of the year, as shown in the sample sheet illustrated above. This provides a daily, monthly and yearly record, all in one book, and has proved useful in checking this material.

CAR DEPARTMENT

THE TANK CAR MAINTENANCE PROBLEM

BY PAUL BATEMAN
Manager People's Tank Line Co., Coffeyville, Kan.

SINCE tank cars constitute a large item of initial expense to almost every producer and marketer of petroleum products, it is of some importance that they be maintained at a point of greatest efficiency with minimum up-keep expense. As an engineer and designer for several years, in the employ of two of the largest car builders in the country, it was a matter of circumstance that one of the outstanding ideas of car builders was forcibly brought to my notice. That is, in substance, design *something different.* The best engineering practice is sometimes made subservient to the principle of designing something on which a claim for a patent may be made.

This practice has resulted in innumerable types of cars,

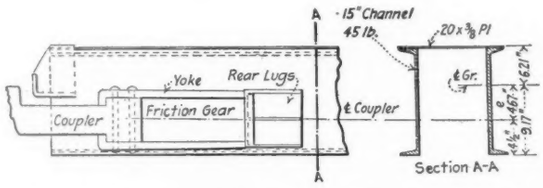


Fig. 1. Typical Arrangement of Underframe and Draft Gear

each type with its own variations, and has greatly complicated the problem of maintenance of equipment. Repair shops have been called into existence by the impossibility of car owners carrying a sufficient variety of parts to repair their cars properly. Although there are some few concerns which employ experienced repair men, the owners of cars must in general trust to inefficient labor to perform work that requires specialized knowledge and experience. Behind the experience, also, there must be knowledge, not only knowledge of how to make repairs, but of why the part requires repairs and of how to prevent a recurrence of the same trouble. To make this clear we will refer to Fig. 1. showing the end of the underframe of a car. There are innumerable variations in the end structure, but the principle must remain the same in all.

REPAIR OF FRICTION DRAFT GEAR

The yoke, Fig. 1., is riveted to the butt end of the coupler and contains certain friction parts, which, in buffing, are compressed by the coupler against stops, or lugs, riveted to the longitudinal beams, or sills. In pulling, the yoke is brought into play and performs the same duty in a reverse direction, by compressing the friction parts against the front stops or lugs.

When originally installed the friction draft gear is provided with sufficient travel to enable the full capacity of the gear to be utilized. Any shock in excess of the capacity of the gear is absorbed by the horn of the coupler striking against the buffer on the end of the sills, after the gear is compressed to its full capacity.

The gear, as installed, is not at the center of the sills, due to details of construction based on truck clearances, and the necessity of keeping the center of gravity of the loaded car as low as possible and there is approximately a 200,000-lb. shock on a 13 in. to 15 in. girder with an eccentricity of about 4 in. to 6 in. Any shock above the absorption capacity of the gear is absorbed by a direct blow against the fully compressed gear which now acts as a rigid block. When wear on the friction elements develops, the end clearance between coupler and buffer block is eliminated and the impact load in excess of the gear capacity is received by the buffer. The gear, as originally installed, gives protection to the car, but when the friction parts wear, more and more of the impact load is directly transmitted to the buffer. As the latter has relatively little resiliency, it is only a question of a short time before it is broken, thus bringing the full load on the gear and thence directly to the sills. The obvious result is that the sills spread and buckle, or else the rivets on the rear draft lugs are sheared, sometimes both. The usual procedure has always been to say, "Oh, let it ride, the sills are all right, we'll fix it sometime." When it is finally released for repairs the first and only thing done to the car is to put on a new buffer and let the worn-out gear alone.

If the gear has worn so that the first 1½ in. of travel has become non-effective, there will be left only 1¾ in of useful travel of the original 3¼ in. giving a retarding value of only about one-fourth of the capacity of the gear. (Fig. 2.) With the full load of a moving train, having a possible buffing shock up to 1,000,000 ft-lb., it is not hard to imagine the effect on the new buffer casting. This is not an isolated case but is the usual procedure all over the

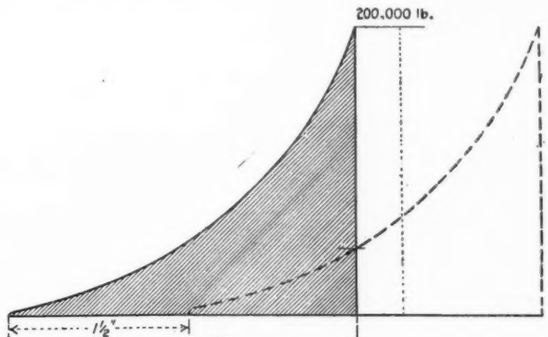


Fig. 2. Diagram Showing Reduction of Draft Gear Capacity with Decrease in Travel

country, not alone with the refiners, but also with the railroad companies and even some of the private repair shops.

In dealing with these buffing forces, kinetic energy must be considered, which does not permit of the same assumption for fiber stresses as in the case of static loads. Under static loads a column can be figured at its full value, with each of

the fibers bearing an equal portion of the load. Under these conditions, however, there are two variable forces, one along the center line of the coupler and the other along the center line of buffer impact, the latter after the frictional resistance of the gear has been absorbed. In addition there are the forces compounded by secondary forces which cause torsional stresses. These latter are caused by inequalities of tracks, different heights of couplers, impacts on curved track, couplers being off center, etc. Although termed secondary forces, they are really as much a part of the primary forces as are any others. In tank car designs, it is not necessary to consider the deflection due to loading on account of the loads usually being concentrated at the bolsters and thence transmitted directly to the truck, so the sills bear only the compound load which is due to the conditions previously mentioned.

The above case, as illustrated, is indicative of the usual methods employed in making repairs. No thought is given to the cause. The best way to make repairs, of course, is to prevent the necessity. However, in conditions as they are, the best procedure is to remove the slack travel of the coupler by renewal of necessary parts and by placing shims between the gear and the lugs. After that, see that the correct position is maintained.

TRUCK REPAIRS

Reference to Fig. 3 shows the usual design of arch bar truck construction and the lines of force with their attendant results. We will suppose a loaded car to be in a rapidly-moving train, when an emergency application of the brakes is made. The braking power is from 70 per cent to 90 per cent of the light weight of the car which, in a 38,000-lb. car of 8,000 gal. capacity, loaded with gasoline, is 30 per cent to 40 per cent of the total weight of the car. The result is that the trucks receive a direct load at the center plate due to the inertia of the entire loaded body of the car at whatever speed it is traveling.

It has seemed inconsistent that one part of the car—the sills, through the coupler—should be used to start the car, and another and much lighter part—the brakes operating on the trucks—should be used to stop it. The writer sees no way, at the present time, to improve the basic principle of this.

The resultant tendency in brake application is to transmit a load to *one* side of the center plate and generate torsional stresses tending to rotate the bolster. This load very naturally comes on only one side of the truck springs, which are intended always to act as a unit. The result is that the springs compress unequally and throw the bolster against the columns with unequal bearing. This causes failure in the columns by tearing the column bolt through the wearing surface of the column. A condition of this kind is usually caused by neglect in allowing nuts of column bolts to become loose, thus permitting the arch bars to spread and allowing excess clearance. Quite frequently the cars, as originally built, have entirely too much clearance.

The material wear of the column guides on the bolster should be taken up by placing shims on one column or else on the column guide on the bolster. This is almost never done as it requires that the truck be practically dismantled. Another cause of trouble is the rapid rounding of curves at which time the loaded car seeks a tangent and the trucks must follow the rails. That causes the bolsters to exert more pressure on one set of springs than on the other, thus allowing the springs to slip and quite frequently lose out. Improper side bearing spacing and clearance are very usual causes of truck failure and are also often responsible for derailments.

The principal instructions would seem to be to keep the truck tight and see that the wooden shims, above or below springs, are renewed at sufficient intervals to insure that they are solid. These shims are made of seasoned oak but they decay very rapidly and allow the springs to settle into them, thus increasing clearances to an unsafe margin. Side bearing clearances must be kept at the proper point, $\frac{1}{8}$ in. to $\frac{1}{4}$ in. between top and bottom.

REPAIR OF TANKS

Of the tanks proper little need be said except that all *indications* of leaks should be immediately looked into as stains on the outside usually mean that the caulking edge of the sheets and rivets on the inside has deteriorated. The tank should not only be caulked on the outside but more especially on the inside. It might be stated that caulking on the inside is almost never practiced except in the shop where its necessity is understood. The fact that inside caulking is obligatory, under Bureau of Explosives' Rules, seems to be overlooked. Leaks are quite commonly caused by deflection

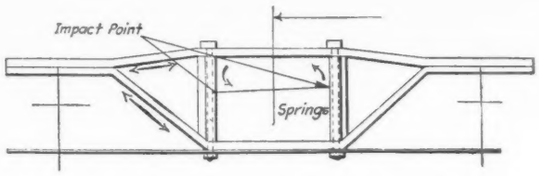


Fig. 3. Forces Acting on Arch Bar Truck

of the sheets of the unsupported end portion of the tank which causes distortion of the sheets at riveted joints.

The safety valves ordered to be used have always been a source of wonder to the writer, particularly as to why it seemed necessary to provide 40 sq. in. of safety valve outlet surface while the largest locomotive using superheated steam and a pressure of up to 250 lb. per sq. in. has only about 10 per cent of this area. The Master Car Builders Association has designed a device using a spring balance to determine the proper point at which to set the valve. Inequalities of bearing surface on the valve seats seem to be overlooked, consequently there is practically no guarantee that the valves will hold any pressure whatever. All valves should be removed and ground in with emery in oil, then set to the proper point under a test by compressed air. The valve question is not only a maintenance problem but one in design, which it is to be hoped will have the attention of qualified engineers.

The advisability of keeping cars well protected by paint is too well known to require more than passing comment. That comment is mostly directed toward the policy of merely making the cars a good advertising sign board instead of seeing that the painting is properly done. Cars, particularly the tanks, should be thoroughly cleaned preparatory to painting as the improperly cleaned car will not held the best paint made. The company with which I am connected has found it advisable to put the problems of painting up to the paint manufacturers, using their knowledge and experience in connection with our own.

One of the greatest causes of tank cars being neglected is the attitude of certain railroads, particularly at competitive points. When an inspector refuses a "bad order car," a competing road's inspector will take it and so drum up business for his road. If it is impossible to run the car in its condition as accepted, temporary repairs are made. In fact, anything is done that will get it out of the yard at the point of origin. The owner is very grateful to the railroads accepting the car and consequently the accommodating railroad gets the future business.

This policy can have only one result, and that is evident when it is stated that the policy is pursued in endless chain fashion, the original road accepting cars that even the first offending road refused to handle.

Delegates to the Convention of Car Inspectors and Foremen.

CAR INSPECTORS AND FOREMEN MEET

Continuation of the Discussion of the Changes in the Rules of Interchange; Other Business

A REPORT of the preceedings of the opening session of the nineteenth annual convention of the Chief Interchange Car Inspectors' and Car Foremen's Association was published in the October issue of the *Railway Mechanical Engineer,* page 593. This included a discussion on Rule No. 2, at the close of which a committee was appointed to consider the wide diversity of practice in interpreting this rule in different sections of the country and report later to the convention. The following report was later submitted and adopted unanimously: "The committee does not feel it consistent with the basic interest and purpose of this rule and the decisions given thereon by the administration that we should recommend any changes in the application of the rule other than the proper supervision by those in authority at the several terminals and interchange points, consistent with local conditions, more especially on point of inspection and repair track facilities."

Following the discussion on Rule No. 2 the association proceeded to the consideration of the changes in the rules as recommended in the report of the Arbitration Committee presented at the 1919 convention of Section III, Mechanical. An abstract of a portion of the discussion of the rules under this head was published in the October issue. Only a part of the rules was covered, however, and a more complete abstract of the discussion of all of the rules is given below.

RULE 32.

(Delivering company responsible.) Dome cover or safety valves missing from tank cars. Material missing from cars due to handling on unloading machines. Removing or cutting out parts of car to facilitate loading or unloading. Known theft of parts of car occurring on handling line. Damage to any car (including cars on ferries or floats) if caused by: (a) derailment, (b) cornering, (c) sideswiping, (d) collision or impact other than that occurring in regular switching, (e) handling of cars with broken or missing couplers, or couplers out of place, (f) colliding with or shoving over bumping posts or other fixed obstruction, (g) shifting of loads from other cars, (h) overloading, (i) explosion, (j) collapsing buildings or other structures on right-of-way, (k) unconcealed fire damage (l) flood, (m) storm where car is derailed or destroyed, (n) failure to close hopper or drop doors before moving car.

T. S. Cheadle: I would like to know if any trouble is experienced with the shifting of loads?

F. C. Schultz: It is our practice to charge the delivering line for any damage on account of improper loading or shifting of the lading.

T. J. O'Donnell: Have any of you considered what the Arbitration Committee means by "impact." Wouldn't that run into the combination of defects?

F. G. Schultz: If a car is damaged in a collision with a number of cars in a train, it is not an owner's responsibility.

J. C. Keene: (Wabash) Unless the car is derailed, cornered or sideswiped, the owner is responsible.

F. C. Schultz: I think this was changed to take care of a case where a private line car was broken entirely in two and there was no evidence of derailment.

T. J. O'Donnell: If investigation showed the damage occurred in connection with an accident, it would be straightened out.

N. Marple: (M. C.) I am a member of an O. S. & D. committee and am watching all cars that come in on the repair track to ascertain the condition of the lading. Cars have to be opened to make repairs to draft gears, and 90 per cent of them have the loads scattered all over the car and the draft gear damaged. Therefore, we want to be careful in what we say is ordinary switching.

T. S. Cheadle: Regular switching service on one road isn't regular switching service on another. I would be glad if we could get an idea of just what that term means as commonly used.

H. W. L. Porth (Swift & Co.): I think the intention was to clarify the terms wreck and fair and unfair switching. It is a matter of judgment as to the damage done to the car. Under the old term, the case brought up was a private line car that had been demolished in unfair switching, but the trucks of the car had not left the rails, hence there was no derailment. The intent of the rules is fairness and judgment of course must enter into the interpretation of these rules.

G. Lynch: The term "wreck" has been eliminated and "collision, impact and regular switching" substituted. If impact is to be considered we will have a great deal of

damage done by impact because we must couple automatic couplers by impact.

T. J. O'Donnell: Isn't it fair to presume that this rule is a help to us? We had nothing to guide us before.

G. Lynch: We had owner's responsibility for all missing parts of a car in fair service, and we had Rule 32 which covered unfair usage.

J. P. Carney (M. C.): That rule is to get rid of the old, weak equipment and make the owners responsible.

F. H. Hanson (N. Y. C.): You are not going to be able to tell whether the car was moving 5 or 20 miles an hour. I think we should go on record as saying the owner was responsible unless the car was derailed, sideswiped or cornered.

President Stoll: In the absence of any proof that the car was in a wreck, how can it be proved when the car is delivered to the other road in interchange? If the railroad is honest, it is an easy matter.

C. M. Hitch: This rule is plain enough, I believe, if we are all fair. A man who is guilty of damaging another man's car knows whether he is responsible or not; let him comply with the rules and card the car; he knows whether it was fair switching or not. If a cut of cars runs down without a rider and smashes a car, I would call that unfair switching.

A. Armstrong: I know less about Rule 32 now than I knew when I left home and an explanation will be expected of me when I return. I would like to ask an interpretation of this rule.

W. S. Elliott (St. Louis): Mr. Carney brought the situation out very clearly. There are times when a weak car is broken in two. There is another case where a car is in good condition and 10 or 12 loads of coal are dropped down against it. That is not regular switching.

G. Lynch: If anyone can tell me what a collision is and what a wreck is, or can tell me what impact is, I would be very glad to get a definite understanding of these terms.

W. S. Elliott: It seems strange that the chief interchange inspectors should disagree on this rule. It is not a new condition with us. On the steel cars we have had practically the same rule. I have had to call Mr. Halbert over time and again to verify my judgment on whatever the case might be. Where there is a chief joint inspector, there should be no trouble. You ought to be able to know what reasonable switching is. I take a fair and liberal interpretation of it and do not anticipate any trouble at all.

M. W. Halbert (St. Louis): The only contention I see is on collision or impact. The chief interchange inspectors at large interchange points inspect all cars that are damaged sufficiently to require carding. The only thing we can do is to use good broad judgment and treat both companies fairly in making a decision. When a car is broken in two you can invariably detect evidence to show whether the damage was done in ordinary switching or rough usage. As chief interchange inspector, I make a decision, and it is up to the road that gets the car to protest afterwards. If it is decided I am wrong there is no harm done. I always try to give the receiving line and the delivering line the best of my judgment. If we make a mistake, let the Arbitration Committee correct us.

E. H. Wood (M. C.): Rule 32 is as clear as water. It shows us how to get rid of a lot of old equipment that should not be in service at all. If a car wont stand up in regular switching, it should be taken out of service.

F. H. Hanson: I move that it is the sense of this association if cars are broken in two, but the trucks do not leave the rails, the owner will be held responsible if there is no evidence of derailment, cornering or sideswiping.

The motion was seconded and carried.

G. Lynch: In regard to missing cross braces, before it was owner's responsibility. Now there is a line drawn there. Damage caused by unloading machines is delivering lines responsibility. That should be made clear.

T. J. O'Donnell: Don't you make the owner responsible for a missing hopper door; aren't we safer with this rule?

G. Lynch: The owner will contend that it was removed.

T. J. O'Donnell: Sometimes when opening hoppers the doors are broken or torn off. Those are cases where the Arbitration Committee is trying to protect the owner. It is better to be liberal than technical.

F. C. Schultz: Who can decide whether the material has been actually stolen or thrown away?

G. Lynch: At Cleveland there are six coal loading machines where cars are unloaded into boats. The inspection does not determine whether the inside cross braces are missing or not. They may be missing. The car is returned to the delivering line and these inside braces are found missing and there is a possibility that they were missing when the car was offered in interchange. Is the unloading road to be made responsible for the missing parts? How are we to decide on the interchange track or when cars are found on the repair track damaged, when there is no other damage to the car?

A. Berg (N. Y. C.): Shippers use clam-shells and other devices for unloading or dumping cars. It was felt that if the road that delivered the car was made responsible they would take steps to prevent industries unloading cars from damaging the equipment. The rule will accomplish just what was intended.

T. J. O'Donnell: I think Mr. Berg has struck the keynote.

J. S. Naery (C. I. & L.): A missing inside brace is a small item but bolsters are also borken on unloaders.

C. M. Hitch: I have seen a great many cars handled on dumping machines but I never saw a truck bolster or body bolster damaged. If that condition prevails there is a weakness in the construction of the bolster.

H. A. Lightner (I. C.): As to missing parts when the car is unloaded, you would to be able to determine whether the part was missing when the car was loaded or was damaged in unloading.

RULE 33

Owners will be responsible for the expense of repairs to safety appliances where not involved with other delivering line damage, except damage to running boards on tank cars when sideswiped or cornered.

F. W. Trapnell: Under the present rules in some parts of the country, defect cards are being secured for running boards on tank cars that have been cornered and sideswiped that have no other delivering line damage. I cannot see how they can be furnished under the rule.

T. J. O'Donnell: The old rule does not give any authority to handle it on that basis.

F. C. Schultz: If the ladder on the end of a car is bent, it is owner's responsibility, but when the car body is damaged as well it is delivering line responsibility. The construction on a tank is such that the running board is invariably broken.

F. W. Trapnell: Rule 33 now exempts running boards from owner's responsibility because they are safety appiances. I believe that is a reasonable exemption. If it was not owner's defect before this recommendation came in, why the necessity of making this recommendation?

H. W. L. Porth: We have had cases of cars coming into our yard with grab irons entirely broken and no evidence of any defect or damage to the car that could be carded, although the safety appliances were damaged beyond repair.

A. Herbster: The Arbitration Committee does not feel that a running board on a tank car can be damaged in fair usage and, therefore, makes it a delivering company responsibility.

T. S. Cheadle: A tank car with a running board damaged is a delivering line responsibility under the new rule,

but a car other than a tank car with the running board or safety appliances damaged is owner's responsibility.

RULE 66.

(Owners responsible.) Periodical repacking of journal boxes, regardless of the responsibility of delivering company for change of wheels, journal boxes or journal bearings. No charge shall be made for repacking unless all boxes are repacked. No charge shall be made if the repacking is done within nine months from date stenciled on car. If car bears no stenciling, showing date of previous repacking, all journal boxes may be repacked, if necessary, and charged for.

(a) All journal boxes shall be repacked with properly prepared packing (new or renovated) at least once every twelve months, at which time all packing will be removed from the boxes and the boxes cleaned; dust guards to be renewed when wheels are changed.

(b) The date and place (railroad and station) where the work is done must be stenciled on the car body near the body bolster at diagonal corners in 1-in. figures and letters, using the same station initial that is used for air-brake stencil.

(c) This work to be done as far as possible when cars are on repair track undergoing heavy repairs. When on repair track for heavy repairs, cars which have not had boxes repacked within nine months will have all boxes repacked and the record stenciled on the car as above.

(d) This does not contemplate any change in the intermediate packing of boxes when it is necessary to do so. No change should be made in the stenciling unless all boxes are repacked.

J. J. Gainey: What is meant by repacking boxes? Is it intended to remove all the packing and take it to a vat and renovate it, or just have a man who goes around with a pan, put it in the pan and shake it out and put it back in the box again? Fifty per cent are doing it that way with unsatisfactory results.

J. C. Keene: If that is being done it ought to be corrected. The packing should be taken to a renovating plant repaired come home, to tear the work down to see that the repairs are done properly.

A. Herbster: I have been in one shop that made it a practice to tear out everything that railroad repair men put on the car; it was not a large corporation.

N. Marple: We all want to play fair as near as we know how, but even when we make repairs as near like the original construction as we can, we get joint evidence cards showing wrong repairs were made.

F. C. Schultz: I believe it is advisable for the railroads to return private line cars to the owners for repairs as the average railroad repair shop is not equipped to make proper repairs to these specially constructed cars.

F. W. Trapnell: The private car owners must know that the car is in shape to carry the contents to its destination with proper icing. We have discouraged making any repairs to wrecked refrigerator cars and are sending the cars to the owner's plant.

J. J. Gainey: A railroad company can repair a refrigerator car properly. We had a refrigerator car in a while ago, and I gave instructions to have the car absolutely perfect when it went home. Every day I looked to see what work was being done on it. The car went to an interchange point and joint evidence was issued for 3¼ in. roofing instead of 5¼ in.; joint evidence also covered lemon color instead of a deep orange. The joint evidence

J. J. Gainey
First Vice President

W. J. Stoll
President

J. C. Keene
Secretary-Treasurer

and thoroughly renovated and returned. Either new or reclaimed packing can be used as desired.

T. S. Cheadle: It is not proper to render a bill under Rule 9 unless renovated or new packing is used.

J. C. Burke (U. P.): The rule states plainly that new or renovated packing must be used.

C. M. Hitch: This is one of the best rules that has been passed. I certainly would not render a bill if the boxes were not repacked in accordance with instructions, but I will use reclaimed packing the same as new. It should be understood that in cases where all boxes on a car are not repacked, no bill is to be presented.

N. Marple: The cost of performing the work is greater than charge allowed under the rules.

RULE 88.

In order that repairs of owners' defects may be expedited as fully as possible, foreign or private line cars may be repaired by the handling line by using material from their own stock instead of ordering material from car owner, as prescribed by Rule 122, in which event the repairing line must issue its defect card for the labor only of correcting such improper repairs, and defect cards should be so marked.

In case of delivering line defects, defect card shall be issued for both labor and material for correcting the improper repairs.

N. Marple: Are there any private car owners here who can state whether it is the practice, when cars that have been

card came back from our staff officer and I wrote to the owners. They stated that all they were going to ask for was a card to change the color. In ten days no one could have told one color from the other.

N. Marple: You have to make the car safe to go home and you are losing all the money that you expend on temporary repairs.

H. W. L. Porth: There is a difference between an ordinary refrigerator car and one that has to carry beef. It has been my experience that in most cases cars are returned when in need of repairs, and the private lines in general encourage this practice as they prefer to do the work themselves.

RULE 95.

In reference to a recommendation that this rule be changed to include missing brake beams and other brake details, as formerly covered, the Arbitration Committee recommends the rule remain as at present for the reason that in case of bill for defective or missing brake beams, the average credits allowed under Rule 101 are high enough to offset the value of occasional missing beams, and the billing is thereby greatly simplified. Furthermore, the condition of the missing beam cannot be ascertained and is no doubt frequently defective.

T. S. Cheadle: Would it be proper to issue a defect card if the brake beam was on the line delivering the car?

President Stoll: Look at the changes made by the M.

C. B. in 1918 and you will find that a missing brake beam is owner's responsibility.

J. C. Keene: The price allowed for the beam was made to take care of the condition.

A. Herbster: I do not believe there are enough missing brake beams in interchange to argue about. Repairs are almost invariably made by the company on whose roads the car becomes defective.

RULE 108.

No labor to be charged for the inspection of cars, testing or adjusting brakes, adjusting angle cocks, tightening unions or spreading cotters; still steps, ladder treads or handholds, tightening or straightening on car.

No material or labor to be charged for the following items of repairs: 1. Air-hose gaskets, applied, except with hose complete, applied. 2. Brake pins or key bolts, applied. 3. Brake ratchet wheel keys, applied. 4. Brake-shaft rings, applied. 5. Brake-shoe keys, applied. 6. Carrier iron, Bettendorf type, when turned over, no charge for adjustment. 7. Coupler release clevises, clevis links or chains, clevis pins or bolts, applied. 8. Lag screws, applied except when used to complete other items of repairs not herein listed. 9. Nuts or lag screws, tightened. 10. Nuts, ¾in. or less, applied, except when used in renewal of bolts. 11. Nut locks, or lock nuts, applied. 12. Release-valve rods, repaired or applied. 13. Straightening brake shafts and uncoupling levers when not removed from car. 14. Spring cotters and split keys, applied. 15. Staples, applied. 16. Wood screws, applied, except when used in renewal of running board. 17. Washers, applied, except when used in renewal of bolts.

No charge to be made for the material or labor of lubrication, except as provided in Rule 66.

N. Marple: Do you not think that minor items of repairs on which no bill is to be rendered under the rule will be neglected especially in train yards?

President Stoll: The general opinion was that the items of repairs referred to were necessary from a safety standpoint and would be taken care of.

CIRCULAR 25, RULE 8.

In compliance with the recommendation of the Interstate Commerce Commission in Case No. 4906, "In the Matter of Private Cars," a second paragraph is added to Rule 8, effective April 1, 1919, as follows:

When repairs of any kind are made to cars of private ownership, where such cars are equipped with suitable receptacle, a copy of the billing repair card shall be inserted in such receptacle. The loss of such card from the receptacle referred to, will not invalidate bill for the repairs. This receptacle to be applied by owner at any convenient location on car, provided the location selected will not require inspectors or repairmen to go underneath or between the cars.

C. M. Hitch: In many places the M. C. B. repair data is furnished by the inspectors and their books are sent to the foreman's office. The inspector should be enabled to place a repair card in the receptacle at the time. The best way to handle that would be to have an extra copy of the repair card made and mailed to the owner of the car.

M. W. Halbert: There are only a few private cars being equipped with repair card receptacles.

A Member: Why should the private line car be given more consideration than a railroad car, or why should we be required to put the repair card in that receptacle?

A. Herbster: That was recommended due to the fact that private cars come home more regularly than railroad cars and the owner can check the card with the actual repairs made to the cars, but I do not believe that it has met with the result that the car owner anticipated.

INSPECTION OF LOADS IN OPEN TOP CARS

A question was raised as to the advisability of inspectors making records of depressions in loads shipped in open top cars in order to eliminate leakage enroute and to protect the railroads in case claims for shortage are filed by the shipper. The discussion brought out that at most terminals the inspectors who examine the roofs of the cars are required to note any apparent shortage. A report is made to the agent and the cars are weighed to determine the loss of contents and to establish the amount occurring on each line in case the shipment is hauled over more than one road. In general, if the road does not transfer the load it must participate in any expense due to loss of lading.

UNIFORM INTERCHANGE INSPECTION RECORDS

President Stoll: I received a communication from one of the large interchange points asking me to bring up at this meeting the possibility of making the records of inspection uniform at all large interchange points.

T. J. O'Donnell: Under our present method of inspection in the receiving line yard, there are certain roads that take only the numbers of the defective cars. There are other roads that take the numbers of all cars. I think it is decided if bad order cars are shown that those that are not shown are O.K. We are throwing money away to take the initials and numbers of the good order cars, and I feel that it would serve the purpose for interchange throughout the country, if only the bad order cars were noted.

J. C. Keene: The question was not as to what cars would be recorded, but to adopt some sort of a standard record. At one point a book is used, at another a sheet and at another a card form. It is my thought that we should adopt a standard form of interchange record similar to the interchange sheet which the transportation department has adopted and which accompanies delivery of cars to the other lines. Our road reaches several division points and at no two points do they have the same kind of record or form sheet.

I would recommend the appointment of a committee to look into the matter and report at our next convention. It will take considerable time to go over this subject and I believe that that committee should confer with the car service men or car accountants. We find that in a period of six or seven days there will be as many as 75 errors made in interchange and that the car inspector is usually correct. A great many movements of cars in interchange are lost because of the fact that the roads fail to get the proper record. We feel that the interchange sheets should be checked against the car inspector's record.

F. W. Trapnell: There isn't any more important record for a railroad than the car inspector's record when properly made and if, as a body, we could devise some suitable blank that could be used at all interchange points, we could accomplish a great deal. We use the car inspector's record to verify the agent's record and when we find a discrepancy, we take the car inspector's record in preference to the agent's because the agents sometimes get the seal number in place of the car number.

Secretary Smith: It seems to me that a uniform record is a desirable thing to have, but I do not like the idea of putting all the work on the car inspector. In many places he takes the number of all cars that are interchanged, but in a great many more places he does not take the record of any cars except those to which he takes exceptions, as defective. If we are to recommend a blank which compels the car inspector to write the number of every car that passes through interchange, it is going to put some work on him. He is too busy and besides he is too highly paid to just take car numbers.

F. W. Trapnell: I believe the railroad companies ask that all cars in interchange be recorded by the car inspector. We have no trouble and we interchange several hundred cars a day.

A. Herbster: The elimination of the record of car numbers and initials on all cars was primarily started in order to get the inspector to make more repairs and do less clerical work.

F. H. Hanson: A great many roads have issued instruction to inspectors not to take the numbers and initials of good order cars. The agent has a complete record of all cars interchanged and we are carrying out the instructions of the administration in reporting bad order cars only.

B. M. Waldo (Dallas): We are taking a record of cars that are defective only, but we really would rather take a record of every car. It is embarrassing when the claim agent comes for a record. As long as they depend on us for a record we ought to have something on file from which we can answer the questions. The car inspectors have a great deal of work to do, and I appreciate all that has been said, but I am in favor of keeping a record of all cars

interchanged. It is a small matter to take down the number and initial.

J. C. Keene: I had a little experience on the question of abrogating the taking of the initial and number of all cars in interchange. Where that practice is followed there is no record whatever to protect your department. To illustrate: in going through the yards, I found two or three cars in bad order, showing defects that should have been detected on interchange inspection. The inspector had nothing in his book on these cars and he answered me: "I cannot tell you whether I inspected these cars or not. Perhaps the switch engine got hold of them and took them away. Perhops they were placed on another track when delivered." Unless the inspector has the number and initial he cannot go in any court and make an affidavit that he inspected the car and found it O.K.

President Stoll: Nine years ago the car men of the different railroads at Toledo decided to have the inspectors take a record of all cars. Just before the government took over the railroads they decided to eliminate it. Then the terminal manager took over the bureau and said he wanted a record of all cars taken and the order was put into effect again to take all car numbers. The sheet has been beneficial, not so much to the car department as to the other departments, especially the claim department. Men come from Columbus and Cincinnati to look up records of cars that have been interchanged to fix responsibility, and in every case where the company did not have a record they fixed their claims accordingly. For the good of the service, I believe it is advisable to have a record of all cars.

A. Kipp: That question was taken up on our road five years ago. Our law department prior to that time expected the car inspector to take the number of every car so that he might be able to go into a court and swear as to whether he inspected that particular car, but after two or three years, they decided that it would be better for the car inspector to have a closer inspection and make more repairs and do less clerical work.

E. Head (Wabash): The thought has occurred to me that we will get back to the time when the roads will be in the hands of their owners and a fine will be imposed for penalty defects. We have had suits entered against roads for penalty defects and the record was one of the most important things in the case. Where we did not have a record of the car number and initial the court ruled we had no record and that omission cost us $100.

A. Herbster: If an accident happens it is the actual condition of the car and not the previous inspection record of the inspector that governs.

T. S. Cheadle: Various methods are used for obtaining records. I do not require any record to be kept except of the bad order cars.

On motion the Association authorized the appointment of a committee of five to approve or present to the association at its next regular session for approval a blank form of car inspector's record of cars inspected at interchange points. A committee was appointed, consisting of F. W. Trapnell, T. J. O'Donnell, A. Kipp, A. Armstrong and F. C. Schultz.

ADDRESS BY A. E. BOUGHNER

At the session on Thursday morning, an address was delivered by A. E. Boughner, superintendent of the Missouri, Kansas & Texas, and chairman of the Interchange Committee of St. Louis, Mo. Mr. Boughner said in part: The terminal facilities of St. Louis for the interchange of traffic are really not very good and it has required a united effort on the part of all concerned to keep the business moving. The different avenues choke up very quickly and for that reason rules have been worked out here to always keep cars going forward. They seldom go backward. Some of the government requirements demand that cars with certain defects move backward. Outside of that we do not figure on anything moving back in St. Louis. I believe at the present time an immense amount of good has been brought about and a lot of money has been saved, as well as a lot of controversy avoided by working for the benefit of the whole in connection with the matter of interchange of cars. That is facilitated by government control which has permitted the consolidation of interchange inspection.

OTHER BUSINESS

On motion of T. J. O'Donnell (Buffalo), a telegram was sent to Director General Hines conveying to him the full support of the association.

J. R. Mitchell (W. H. Miner) suggested that since the association is made up of car foremen as well as interchange inspectors, the organization should take up car subjects in addition to the discussion of the rules of interchange. W. G. Wallace called attention to the fact that the International Railway General Foreman's Association at the 1919 convention changed the constitution and by-laws to make car foremen eligible for membership. This action was taken because the members felt the need of educating the general foremen in car department matters as this knowledge would be essential if they were promoted to the position of master mechanic where they would have charge of both departments. He urged the association to broaden its activities in order to stimulate interest and secure recognition from the higher mechanical officers.

Arrangements were made with the Simmons-Boardman Publishing Company to publish the convention report in the *Railway Mechanical Engineer* and the membership dues were increased to include subscription for the perodical.

On Wednesday a special train was provided for the members in order that they might make an inspection trip around the St. Louis Terminal District.

At the closing session L. T. Canfield of the Union Draft Gear Company delivered an address in which he emphasized the importance of the work done by the association and called attention to the opportunity the members had for noting the defects which developed in cars after they had been placed in service and for recommending improvements in the design.

Invitations were received from several cities asking that these places be considered when deciding on the location for the next meeting. Among the places suggested were Niagara Falls, Ont.; Buffalo, N. Y.; Saratoga Springs, N. Y.; Asbury Park, N. J.; Cleveland, Ohio; Detroit, Mich.; Harrisburg, Pa.; New York City and San Francisco, Cal.

ELECTION OF OFFICERS

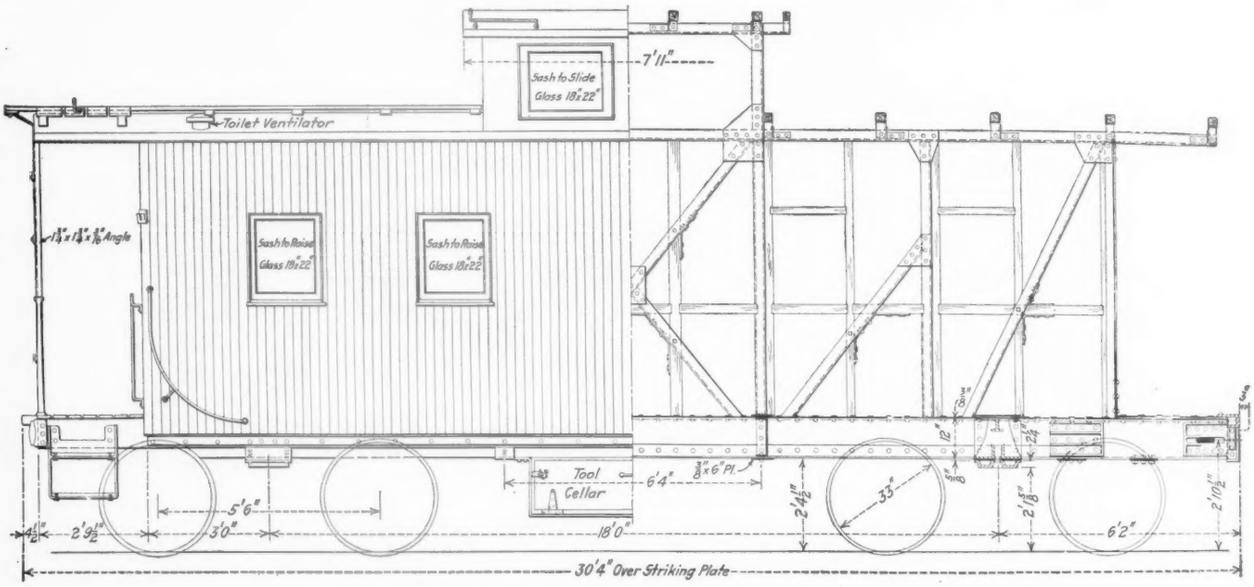
The following officers were elected for the year 1919-1920: President, J. J. Gainey, general foreman, car department, Southern; first vice-president, E. Pendleton, car foreman, Chicago & Alton; second vice-president, A. Armstrong, chief interchange inspector, Atlanta, Ga.; secretary-treasurer, J. C. Keene, chief car inspector, Wabash. Members of executive committee, W. J. Stoll, Toledo, chairman; H. J. Smith (D. L. & W.); W. P. Elliott (T. R. R. A. of St. L.); J. E. Gordon (N. Y. C.); C. M. Hitch (B. & O.); E. H. Mattingley (B. & O.); E. H. Hall (C. G. W.) and Charles Adams (N. Y. C.)

CARS AND LOCOMOTIVES IN RUSSIA.—The Ironmonger states that at the declaration of war Russia possessed in the neighborhood of 30,000 locomotives and 570,000 cars and that at the time of the revolution there were 6,200 locomotives and 120,000 cars in good condition, with 3,600 locomotives and 145,000 cars needing repairs. This has been considerably reduced and this year a new commission of the Russian government does not record more than 4,000 locomotives and 95,000 cars.

U. S. R. A. Standard Caboose Car

Design Recommended by the Railroad Administration; Strong Underframe for Heavy Pusher Service

THE REQUIREMENTS of the laws of the various states in this country regarding railway caboose cars make it very desirable that a standard design be adopted for the construction of this class of car. To meet this need the United States Railroad Administration has issued an approved standard design for such cars. It is not proposed to require that cars must be built to these drawings, but to provide a design that, if conformed to by the railroads in building new caboose equipment, will insure the gradual elimination of cabooses of weak construction or faulty design. The proposed design is a 24-ft. caboose of the composite type, having a steel underframe and superstructure, with wood outside sheathing and interior finish.



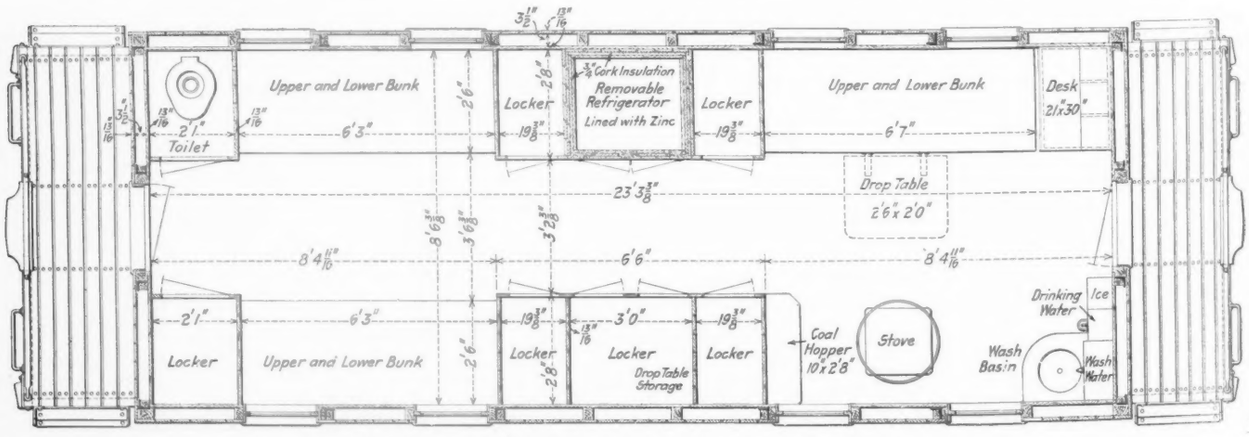
Side Elevation of U. S. R. A. Standard Caboose Car

This design supersedes the original designs which provided for an all-steel caboose and a composite type. The first plan called for a caboose 25 ft. long but was only a preliminary draft and was never approved for the use of the railroads. This article shows the 24 ft. caboose recommended by the Railroad Administration for the future construction of cars of this class.

THE SUPERSTRUCTURE

The body framing is built up of 3-in. by 3-in. by 5/16-in. angles, the side and end posts being adequately braced by angles of the same size and with gussets of ¼-in. steel plate securely riveted at the side sills and top plates and at intermediate points on the side posts.

The carlines are of the composite type with 2½-in. by 2½-in. by 5/16-in. angles, formed to a 24-ft. radius and secured by rivets to the side top plates. The cupola frame is constructed of 3-in. by 3-in. by 5/16-in. angles with the same type of carline that is used on the main body framing. The roof may be a canvas or plastic covering over roof boards secured to the carlines. Wooden filler posts and



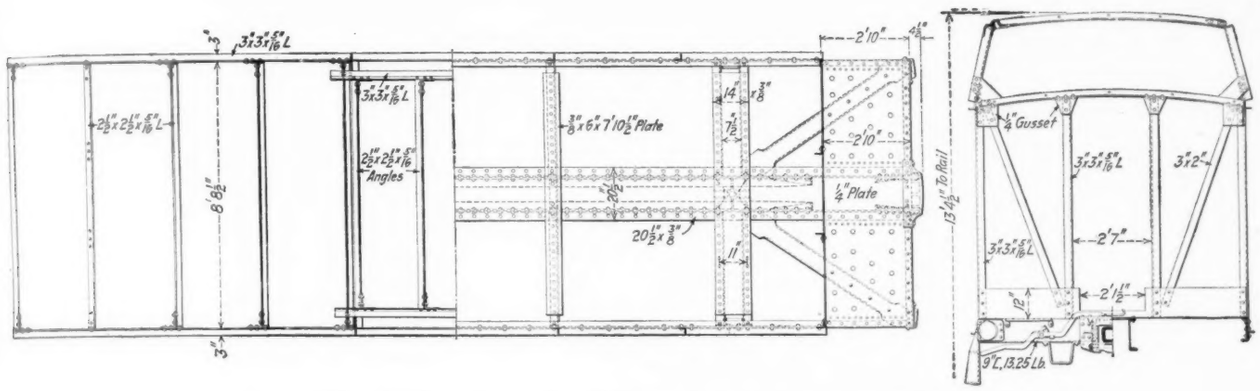
Floor Plan of Proposed U. S. R. A. Standard Caboose Car

plates are secured to the angle iron frame and to these the 13/16-in. inside and outside sheathing is secured.

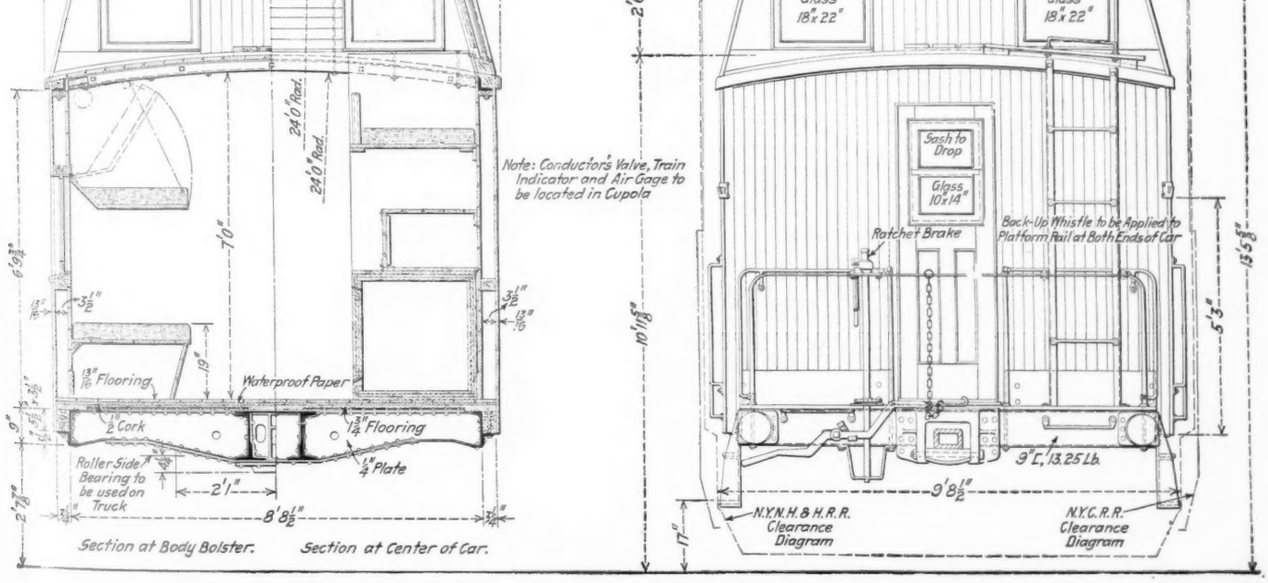
THE INTERIOR

The floor space is 23 ft. 3⅜ in. by 8 ft. 6⅜ in. inside of the sheathing, with a clear space of 3 ft. 2⅜ in. at the closest point in the aisle between the interior fittings. Two upper and two lower bunks, 6 ft. 3 in. by 2 ft. 6 in., and one upper and one lower bunk, 6 ft. 7 in. by 2 ft. 6 in. are conveniently located. The upper bunks fold upward against the carlines, giving ample headroom above the fixed lower bunks, which can be used as seats when not in use for sleeping purposes. The conductor's valve, train indicator and air gage are located in the cupola and seats are provided in each side of the cupola for observation purposes. The headroom in the main body of the car is 7 ft. and in the cupola 9 ft. 2 in. A desk is provided for clerical purposes, being so located that one end of a lower bunk serves as a seat. The tank for wash water, the wash basin and a drinking water tank are conveniently arranged in one corner of the caboose. A refrigerator, numerous lockers and drop tables, a toilet, a coal stove for heating the car, make up the complete equipment.

There are four windows, which may be raised, having 18-in. by 22-in. glass, in each side of the car, a window having a glass area of 10 in. by 28 in., with an upper drop sash, in the door at each end, and four windows with sliding sash having glass 18 in. by 22 in. in the cupola. The floor consists of 1¾-in. rough flooring, a half-inch layer of cork covered with a waterproof paper, and a 13/16-in. top flooring. A platform of ample width, formed of ¼-in. steel plate with wooden cleats laid crosswise of the car, is provided at each end. The roof canopies over the platform, thus giving some protection from the weather. Hand holds, ladders and steps are placed in the most convenient locations. A ratchet hand brake is applied and provision made for the application of a back-up signal whistle at both ends of the car. The uncoupling apparatus is connected by a



Plan of Underframe and Plan and End View of Body Framing of U. S. R. A. Standard Caboose Car

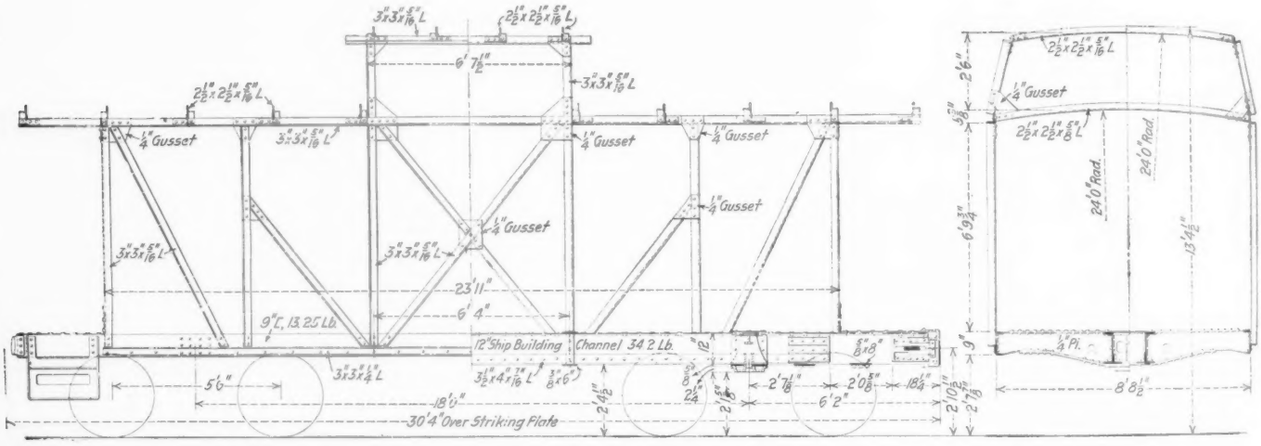


Cross Sections and End Elevation of U. S. R. A. Standard Caboose Car

chain to the platform rail so that the car may be uncoupled without leaving the platform.

THE UNDERFRAME

In order to withstand the severe service in which many cabooses are used, where there are heavy grades and pusher service is required, the underframe is of unusually strong construction. The center sill is built up of 12-in., 34 2-lb. shipbuilding channel with a 3½-in. by 4-in. by 7/16-in. angle riveted to the bottom inside edge of the channel for the entire length of the sill. The top cover plate is of ⅜-in. steel plate 20½ in. wide. The side sills and end sills are made of 9-in., 13.25-lb. channel section, the side sills being reinforced on the outside with a 3-in. by 3-in. by ¼-in. angle, which also serves as a support for the side nailing strips. The body bolster diaphragms are formed of ¼-in. pressed steel plate with a 3-in. flange. The top bolster cover plate is of ⅜-in. and the bottom cover plate of ⅝-in. steel plate, both 14 in. wide. The two intermediate cross-bearers are of ¼-in. pressed steel plate with a ⅜-in. steel top and bottom cover plate 6 in. wide. Diagonal braces at each end give additional rigidity to the underframe, and it should meet the requirements of the most severe service. The draft sills are designed to permit the application of any of the standard draft gears. A tool cellar of ample size is secured to the underframe.



Side Elevation and Cross Section of Steel Frame for U. S. R. A. Standard Caboose Car

THE TRUCK

The car trucks recommended by the Railroad Administration are of the four-wheel type with cast steel bolsters and side frames, and have a 5-ft. 6-in. wheel base. The wheels are to be 33 in. in diameter, mounted on axles having a 4¼-in. by 8-in. M. C. B. journal.

General Data

Length over striking plate	30 ft.	4 in.
Length over end framing	24 ft.	0 in.
Width over body framing	9 ft.	2½ in.
Width over side sills	8 ft.	8½ in.
Height from rail to top of main roof	11 ft.	1 in.
Height from rail to top of cupola roof	13 ft.	4½ in.
Diameter of truck wheels		33 in.
Wheel base	5 ft.	6 in.
Distance center to center of trucks	18 ft.	0 in.

This design is made to conform to the laws of all of the states except those of Missouri, which differ radically from those of the other states. It is intended to prevent the agitation of railway employees for state laws which, if adopted, might make it impossible in such states to use cabooses that are lawful in other states, and would result in the poorest cabooses collecting in those states having no stringent laws on the subject.

No attempt has been made by the Railroad Administration to specify all of the details of construction, but only to provide a general design for common use by the various railroads.

SUGGESTIONS FOR IMPROVING DRAFT GEAR MAINTENANCE*

BY L. T. CANFIELD

At the present time very few people are giving the question of draft gear maintenance serious thought, and the cost of car maintenance, damaged lading and loss of service due to bad order cars, leads me to make a few suggestions.

First. The car inspectors should be carefully instructed on the question of draft gear inspection and its importance to economical operation. I realize that for a while it will be necessary to continue to let some gears run for a while longer, but each repair track should take all it can handle.

Second. Each repair track where a large number of cars are repaired should have as a part of its organization a crew of men in charge of a competent foreman, to repair draft gear, specializing on this just as the air brakes are handled. The foreman should be familiar with all makes of draft gear. In a short time this would result in a reduction in the number of bad order cars as well as in the maintenance cost.

Third. There should be rules making it compulsory to take the draft gear down and make needed repairs at the expiration of three years. Should a car be on a foreign line with draft gears that have had more than three years' service without repairs, the road having the car should make the repairs. The time between repairs may be lengthened if found too short. This would not be a big task. Reduced to the number of cars per day it is only 2,777 cars for the entire country. I would not be surprised if there are not more than 2,777 repair tracks. If so, it would be only one car per day per repair track. There is no rule in effect now, the gears are allowed to run as long as they are not broken or pulled out, or some more expensive part of the car or lading is injured because of the neglect to the draft gear.

The practice of using old draft gear springs in repairs to cars should be watched very closely. If they have taken any permanent set they should be discarded and new ones used. This is not an extravagant suggestion, as the saving of $3.30, the approximate cost of a new spring, may take a couple of inches work (as represented by the drop hammer) out of the draft gear and result in breaking a coupler which would cost $25 to $30, or turn over a piano inside the car, at even greater cost.

*From a paper presented at the General Car Foremen's Association of St. Louis.

MAINTENANCE OF FREIGHT EQUIPMENT*

Economy of Retiring Old Cars; Better Repair Facilities and Greater Interchangeability Desirable

By L. K. SILLCOX

THE economic situation with respect to the performance of that great vehicle of commerce, the freight car, is one of basic importance. Any success in railroad operation corresponds largely to the net number of car miles attained per car per day, which figure ought to be as nearly 40 or above as possible. Why many roads are only showing 30 or even less miles is probably due to many causes beyond the exact knowledge of the writer, but in any event, so far as the problem is affected from the standpoint of design, maintenance and inspection of freight car equipment, a number of conditions deserve calm analysis.

WEAK DRAFT MEMBERS MOST SERIOUS DEFECT

One noteworthy fact, the explanation of which I have tried to investigate, should be first mentioned. Of all the complaints which are general in the operation of freight train equipment at the present time, the behavior of the weakly constructed design of car is found to be the most perplexing, principally due to draft attachment failures in combination with dangerously inadequate running gear members, such as truck, side frames, axles and bolsters. Although this difficulty is in greater measure due to wooden underframe cars, yet it is also noticeable in the case of improperly designed steel cars. Right at the present time, there is a tremendous demand for suitable cars, which is not being satisfied and yet, it would appear to any thoughtful man that too many cars are standing idle which ought to be making their just proportion of revenue mileage. It does not seem to be altogether a case as to shortage of cars, but rather a matter of having more cars made really fit.

It has been said that a very large percentage of cars should be destroyed, especially those of wooden construction. A careful check, extending over a period of seven months in normal heavy trunk line service, has demonstrated that we can expect about 20 per cent or 30 per cent of the house cars used at this time to be of the type which we generally term as weakly constructed not being as yet reinforced with metal draft attachments or ends. The problem to be determined in a decision concerning the retirement or reconstruction of any such car is generally influenced by the distinctive demand for the equipment on the owner's line and a knowledge of whether the expense of betterment or improvement to the existing equipment is offset by the capitalized value of the saving which can be realized in the maintenance account, as well as keeping in mind the better characteristic operation which is practically guarranteed from such a program. Extended observation has often brought out the fact that the capitalized saving in the repair account through the adoption of an intensive retirement program and the acquisition of new high capacity units in equal number or tonnage which are bound to present very much greater service capacity and earning power, if there is a paying demand for tonnage space, has proven most practical. It will never be found possible satisfactorily to determine upon any general policy without a most careful unit study for each class of car, besides being fortified with a liberal knowledge of the exact operating possibilities of the property owning the equipment.

REPAIRS ON FOREIGN LINES MUST BE CONSIDERED

Another serious limitation to our field of selection in the matter of deciding between reinforcement or retirement, and subsequent replacement in satisfactory designs, is the fact that the majority of defects occurring in connection with car equipment when off home lines, except in case of derailment or fire, have only in late years been made owner's responsibility. This is where a vast amount of money is apt to be applied beyond the control of the car owner and will undoubtedly bring about, of its own accord, more systematic analysis in the future as to deficiencies in each class of car in order to guard against the possibility of duplicating repairs to failed members which do not meet present day requirements; so that the sum total of expense for any class of rolling stock does not become excessive, due to a large part of the work being repeated so continuously and carried out beyond the immediate observation of the car owner, resulting in extravagance, though not necessarily for the total equipment owned. Of course, under these circumstances excessive maintenance charges will not often be so easily reflected in system statements covering total ownership, as in grouped classes, which it is desired to observe.

ATTENTION BEFORE LOADING PREVENTS DELAYS

It is especially urgent that the best interests of the shippers and dealers, as well as of the railroads which serve them, be maintained by the inauguration of substantial repair practices which will insure a minimum delay of cars on shop tracks and lines of roads chargeable to their general condition and style of construction. Thorough inspection and repairs of cars before loading and careful attention to brakes, lubrication, running gear and lading after classification at originating terminals are a fundamental necessity. Cars set off on the line of road due to bad order condition of couplers, draft rigging, wheels, brakes, heated bearings, shifted lading and other similar causes are usually the outcome from lack of proper attention at the originating terminal, which results in accidents, destroyed lading and cars, reduced train rating, delays to traffic, blocking of passing tracks, engine and train crew overtime and extraordinary expense for sending men and materials out on the line to eventually make repairs.

WEAK CARS SHOULD BE KEPT ON OWNER'S LINES

As already referred to, it is a fact that at the present time nearly all systems are offering in interchange some loaded and empty cars that are of such design or condition as to make them entirely unfit for the service to be performed on the average trunk line railroad. This class of equipment, which cannot be depended upon to pass properly in main line movements, should be restricted to owner's lines, where it can haul the maximum amount of commercial and company lading with the least liability for delays, transfer or repairs. When a freight car of undesirable class and capacity has outlived its usefulness from the standpoint of commercial utility, age, decay, corrosion, obsolescence or accident, so that the expenditure necessary to put it in serviceable condition is not justified, it should be dismantled forthwith. The intensive movement of tonnage, creating an acute demand for power and a severe congestion in terminals, has at many points made it impractical, due to the time consumed and necessary switching required, to place weakly constructed cars in the rear of long trains. That is why this subject looms so prominently before us today. Tremendous damage is done to these weak cars and especially when not protected against the hammer blows of

*From a paper presented before the Western Railway Club.

modern operation. Not only this, but delays and accidents result from this condition.

REPAIR FACILITIES ARE INADEQUATE

Freight car repair yards have been located at inconvenient out of the way places; repair tracks have been set too closely together for convenience: the facilities for repairing have not been the best, and the consequence has been that cars which should have been returned to service promptly and with repairs properly made have been held out of service longer than necessary and were not properly repaired. Never before has there been such pressing necessity for intelligent work, for proper tool equipment and for shelter for the men employed as at the present time. It is a reflection on good judgment when cars are held out of service for which there is a paying demand at the time, and it would appear that with the attention now concentrated on the railroads, best efforts are not only desirable, but absolutely necessary for a relief of the conditions.

The scope of the operations in commercial value; the great numbers of men coming under the control of the mechanical department; the drift of the times concerning methods for carrying out the work and the very intensive service necessary to transportation matters, as well as the growing importance of economies, all tend to make us focus our attention on these questions. There is no denying the fact that all these matters involve, more than any one thing, the element of men, and if we are going to best the best from our men, we must provide responsible supervision with necessary support and initiative so as to maintain action and make good from day-to-day. The moral responsibility of everyone is as great and as constant whether one is here or there, or doing one thing or another, and this responsibility is in exact proportion to the intelligence of the individual coupled with whatever measure of freedom for action is allowed. It implies leadership and teaching, not in some things to be sure, but in all of the relations that bring individuals together in industry and business, so that our choice, especially among our highest supervisors, should be along most practical and fundamental lines. This is only referred to as a timely suggestion, since it has so far reaching an effect that words fail to emphasize its importance.

GREATER INTERCHANGEABILITY DESIRABLE

The first division of the subject assigned to me has regard for the design of rolling stock. I do not think it is reasonable to believe that the roads will adopt and maintain one standard type of car indefinitely to a single inflexible pattern. There are sure to be improvements and modifications, which different groups of railroad men think it desirable to make and such motive would be difficult to subdue. It would seem proper for the draft lugs, truck frames, truck bolsters, center plates, striking castings, coupler carriers, brake beams, truck springs, drawbar yokes, uncoupling mechanism, brake hangers, drawgear carriers and center plate height of truck to be standardized and made interchangeable to a greater degree than at present, both in new and repair work. It does seem indefensible, that the slight variations made in these parts should necessitate their being obtained from the car owners. In designing a car, what must be considered is the service in which its paying demand rests, not the service in which it may possibly run. It is only fair to assume that every railroad management aims to place into service cars built in a substantial manner. Standards in detail construction have been adopted by the Master Car Builders' Association which have assisted greatly in reducing the amount of stock necessary to be carried. The difficulty seems to be that these standards have not been enforced under mandatory rules and their full practical value has never been properly felt on this account. I believe the time has arrived to introduce additional standards affecting the maintenance of box cars which can also be applied to all types used in interstate service.

The application of steel center sills, as well as draft arms, to old cars will not only prolong their life, but cause them to have a more continuous earning capacity, due to not becoming marked out to shop tracks every few hundred miles for the application of draft timbers and end sills, as well as avoiding damage to adjacent equipment and delays to trains, and in terminals, to say nothing of the tremendous losses due to damaged lading and loss of patronage, where delays and slow delivery become epidemic.

POORLY DESIGNED CARS ARE A SOURCE OF TROUBLE

Mechanical and transportation officers have seen and appreciate the results of poor designing and inferior construction, both as regards wooden and steel cars. One of the surprising features with regard to many steel cars in service which cause the greatest trouble and embarrassment, is that they are not of particularly light construction, but the metal has been disposed with very little regard to the engineering feature of service requirements actually encountered. There is no doubt whatsoever but that many of these cars could be built with at least equal or even lass weight than originally set aside and a perfectly satisfactory structure obtained. This is what is so confusing to the minds of executive officers, when they have purchased and placed into service, not a cheap or even a light car and it fails, then on top of it all, it is necessary later to recommend reconstruction and additional expense in order to stop permanently, a severe leak in the maintenance account. New fads in the design and building of car equipment should not be permitted, or any innovations, until thoroughly tried out and known to be reasonable and capable of standing up in normal heavy service for at least a period of five years, besides being passed upon by uninterested, competent authorities.

It is not alone the larger locomotives being used today which have called for a more thorough investigation of the subject of car design and construction, but also the severe shocks which cars are receiving in classification yards. The superstructure of box cars should receive just as much attention as the underframe and trucks, otherwise, leakage and subsequent loss of metal roof sheets through racking and frames not being kept in alinement is bound to result, and when this happens, it places restrictions on the ultimate utility of the car for service where leakage is harmful.

WOODEN FRAMED CARS NEED STEEL CENTERSILLS

In discussing any problem dealing with the continuance in service of the all-wood car, as compared to an intensive program of replacement in the all-steel and steel underframe classes, the strongest argument in favor of the general adoption of the latter, and one which is barely, if ever, touched upon, is the fact that wooden framed cars are always damaged when in collision with steel underframe cars, while the latter escape uninjured. If, because of their decided economy, the more recent designs of metal construction are continued in use, then it is essential that other cars associated with them should be made strong enough to withstand the severe shocks incident to the movement of heavy tonnage trains now so generally experienced. There is no doubt that the light wooden cars may be strong enough to carry the load for which they were designed, but they need a stiff backbone in the underframe to protect them from being crushed in the middle of a long train or between two heavy cars under impact. The same argument of uniformity holds true of couplers, draft gear and brake equipment. It is for this reason that we must at this time give more positive backing to the need of metal reinforcement programs for cars of light design, rather than hesitating on a questionable economy in operating expense, due to carrying larger loads and less dead weight. It simply must

carrying larger loads and less dead weight. It is a question of modernizing cars or retiring them from service.

WOODEN VERSUS STEEL CARS

With respect to the life of the wooden car, compared with steel, it is well to state that none of the modern steel cars have been in use long enough in general operation to determine their ultimate length of useful service. It has been found, however, what may be expected of all metal coal and other special classes of cars on prescribed lines, having a given commodity and territory; this, of course, is of valuable comparative local use only. There is great difference of opinion about the loss of weight in steel due to corrosion and this may well be expected due to varying climatic conditions experienced, and until some definite conclusions can be drawn, based on a wide range of observation under every service condition, any data used must be employed with caution. Records indicate foundation for the opinion that wooden cars have been in continuous use from 20 to 30 years, but it is probable that such cars have been rebuilt from the sills up once or even more times in that period, so that we ought not to be disposed to question the assumption of the average life of such cars being 20 years. With respect to the high cost of repairs to wooden, as compared to steel equipment referred to, and which is almost always carried on gradually, we must not forget that for steel cars, up until the time rebuilding is necessary, usually only light repairs are carried out, due to the various roads not being equipped to do the heavy work at this time. Therefore, any comparative costs should be viewed with these thoughts in mind and wrong conclusions avoided.

INCREASE IN COST OF FREIGHT CAR REPAIRS

Such a large proportion of failures in units of freight car equipment, as is now being experienced, appears to indicate that there is something radically defective in the elementary handling of the transportation problem or else the maintenance features have been neglected and not kept in stop with the advance movement of the service to be rendered. The cost of freight car repairs has been continually increasing and in somewhat greater proportion than the advance in labor and material accounts would explain. The tendency for such increases can only be offset by providing all means that aim to reduce the number employed and get the greatest possible output from each man. This not only makes itself felt upon the payrolls, but reduces the time cars are held out of service, which is another source of revenue. In dealing with concrete cases showing the increase in freight car repair costs, a table is shown below for eight of the largest Western railroads.

Road	Year	No. of freight equipment cars	Average miles per freight car per year	Cost of freight car repairs per car per year	Cost of freight car repairs per mile—cents
A	1916	66,409	11,593	$69.13	0.599
	1917	70,396	11,853	68.12	0.558
	1918	70,400	12,064	146.52	1.221
B	1916	57,401	8,931	53.98	0.60
	1917	58,256	8,396	66.64	0.80
	1918	55,819	8,987	147.13	1.64
C	1916	47,985	10,974	58.76	0.54
	1917	47,845	11,171	74.98	0.67
	1918	50,079	10,376	133.60	1.29
D	1916	46,925	11,098	85.59	0.80
	1917	46,281	11,191	126.92	1.13
	1918	45,993	10,459	201.23	1.92
E	1916	68,339	13,059	74.66	0.57
	1917	67,828	14,553	88.46	0.61
	1918	69,622	11,145	149.88	1.35
F	1916	67,370	13,053	98.16	0.75
	1917	67,168	11,214	122.93	1.09
	1918	61,457	11,905	266.57	2.24
G	1916	63,143	11,646	120.20	1.03
	1917	64,919	12,377	113.12	0.91
	1918	66,741	12,810	177.18	1.38
H	1916	81,034	9,468	71.48	0.76
	1917	83,147	9,499	84.84	0.89
	1918	72,141	9,377	146.36	1.58

The serious increases in total expense from year to year are attributed more to the character of equipment owned than any other feature and the logical proposal is, therefore, that more rapid retirement of obsolete equipment should be carried out. When such cars are dismantled and permanently removed from service, one of the features which can be expected to effect a saving and prevent such increases as indicated above is the relative reduction in the amount of material used for repairs to old cars. It can be fairly well stated that the total car repair expense is about equally divided between labor and material, under normal conditions where extensive reclamation operations are resorted to locally, thus holding down the amount of new material obtained to a minimum. Most wooden cars are at least 15 years old and many have seen 25 or more years service. Comparatively few of the weakly designed cars complained of have been reinforced with metal draft rigging. Failure of draft attachments and associated parts contribute to the serious increase in cost of repairs.

LIMIT FOR REPAIRS DOES NOT FORCE RETIREMENT OF CARS

It seems to be a general practice to place small limits of expense on these older cars with the idea in mind that these limits would force such cars to be automatically taken out of service as they become deteriorated beyond a point where repairs would be economical. It can be shown that this equipment is on the repair track a large portion of the time, and in each instance just sufficient work is done to run the car a little further owing to the policy of concentrating on light repair work first where a demand for equipment exists. Such a plan of retirement does not work satisfactorily and in the end the roads have far exceeded any proposed sum of money which they planned on placing against these old cars to keep them in service. I do not think anyone who has followed the plan in question has ever found the result in practice any different than stated.

LOW STRESSES PROLONG LIFE OF PARTS

During winter months, and at times of heavy tonnage movement, wrecks and delays caused through breaking down of trucks are very serious matters and the question is always asked as to why such things happen. Fatigue failure in metal truck frames, axles, bolsters and other portions of equipment is characterized by suddenness, and oftentimes occurs immediately after careful inspection has been made. The fractures sometimes disclose a crystalline appearance over part of the surface and it is this feature which has many times given rise to the term crystallized. This supposition, however, has been found generally false, since close examination of metals under stress show no change of the general scheme of internal structure, but under severely heavy stress there appears a gradual breakdown of the crystals forming the member. Metal used for the running gear of cars is more or less ductile, and when these parts are deformed cold, the first yielding occurs in the particular grains which either take the most stress or have the lowest elastic limit. The failure in such metals subjected to repeated stress takes place with substantially no general deformation, but there is, however, considerable localized distress among the structural particles, which increases directly with the number of applications of stress. Car trucks have imposed upon them repeated stress in service and failure seems to develop in proportion to the continuous mileage made. In analyzing specific cases of breakages, they seem to appear almost exclusively through the unification of yielding particles, with the result that cracks develop with final added stress, promoting the extension of this crack into the adjacent area on both sides. Steel must be considered as filled with a multitude of minute flaws, originating at the time the metal becomes solidified. In static testing, steel under stress of about one-half its ultimate strength passes into a semi-plastic condition, in which there is a gradual flow of the material. Under such condition,

the small flaws have almost no effect upon the flow or upon the static strength. When steel is loaded to moderate stresses, the yield is almost entirely elastic in general, but a small portion of its inelastic energy being taken up by the steel itself. In this way it can be reasoned that sufficient material is necessary to any truck side frame or bolster in order to keep down the working load of the material and give long life to the part. Of course, where springs are improperly designed to carry the load, truck members receive hammer blows in service for which they were never designed and this seems to be particularly true in the case of the M. C. B. grouping of springs for 50 ton cars as often they stand practically solid under the static weight of the car and lading. This is a subject which should be placed before the proper committee of the M. C. B. Association.

As a plan of interesting local foremen in the discharge of their duties, it is well for them to have a working knowledge of the money they are spending and a form has been adopted which is filled out daily by the foremen and is wired to the general offices twice a month. Very interesting results have been obtained from this practice and establishes the plan of foremen going over time slips personally to know that labor charges are being properly distributed. With this data, and knowing the amount of work turned out, a good practical analysis is obtained concerning relative efficiency month by month which guards against excess overtime payments and similar wastes.

FREIGHT TRAIN INSPECTION

Before closing this paper, I will only refer briefly to the question of freight train inspection. On the road with which I am connected practices have been adopted which have done a very great deal to couple and unify our efforts, especially in through business, besides positively maintaining the responsibility of each individual engaged and avoiding as much as possible any duplication of inspection.

The desire to save time and cost of inspection by resorting to the so-called safety inspection of some roads has about reached its limit. The class of men that railroads are obliged to draw from, in some districts at least, do not make the most expert inspectors. The saving in reducing the number of men and time to make the usual superficial safety inspection oftentimes proves a serious less, for the result of a derailment or wreck on account of a loose or defective wheel or some other important part of the running gear or brakes which have been overlooked on account of time or judgment, is worthy of serious consideration. No one will deny that all cars are rankly abused, but very little is heard of crews being suspended or even censured on account of damage to rolling stock, no matter what the extent. The ultimate loss cannot be measured by figuring the cost of renewing certain broken parts when cars are abused for premature failure of other parts will follow.

Consideration of overtime and the sixteen hour law, as well as expeditious train movement, demands the minimum lapse of time between that for which the crew is called and that when the train departs. Hence, a train prepared for departure should require no more brake work after the engine is coupled than, at the most, stopping a few leaks in hose couplings and making the formal test. But often today there are greater delays due to making other repairs, or the train proceeds with less efficient brakes than required.

To avoid this, the repairs required must be determined with arriving trains. The incoming engineer should add to the reduction required for stopping enough to fully apply the brakes, and the brakeman should await his advice that this has been done before cutting off the engine. Car inspectors should be present to make an immediate examination and to bad order all defective brakes. Such repairs as ordinary brake pipe leaks, defective hose and wrong piston travel, should next be made, but cars requiring heavy brake repairs be marked for the repair tracks.

In this matter, judgment must be exercised as perishable or other very important loads as well as empties needed at once for such lading, must not be delayed. Neither should other less important cars be held in numbers far greater than the local force can repair in a day if such force is as great as the regular amount of work, including such repairs, would keep busy. The car foreman and the yard master should consult to adjust the foregoing, but when the former removes bad order marks without repairs having been made, he should fill out and apply an air brake defect card to insure repairs at the earliest possible date.

DISCUSSION

G. S. Goodwin (C. R. I. & P. Ry.) stated that at the present time the railroads were justified in making more extensive alterations when reinforceing old cars. He cited the fact that steel frame box cars which formerly could be purchased for $900 now cost $3,000.

T. H. Goodnow (C. & N. W.) expressed the opinion that the retirement of wooden cars is one of the most important problems confronting the mechanical department at the present time. There are still in service a great many wooden cars of 80,000 lb. capacity built between 1902 and 1907 which have as high cubical capacity as cars being built, at the present time. These cars will give good service if reinforced and the work should be done without delay. Mr. Goodnow called attention to the many circumstances which must be considered in analyzing statistics regarding freight cars. He doubted whether any reliable figures showing the relative life and cost of wooden and steel cars were available because the early all steel cars were confined almost exclusively to gondola and hopper types which cost less to maintain than house cars. He called attention to the large percentage of foreign cars which all the railroads had on their lines during 1918 and stated that for this reason the expenditures for freight car repairs did not furnish a true indication of the relative cost of maintenance of the equipment of the various companies. He said the past two years had proved that cars cannot be taken care of as well away from home as when the equipment occasionally reaches the owning road and favored greater standardization of truck and draft gear parts to facilitate maintenance. He indorsed the system of organization in force on the C. M. & St. P. and stated that an individual car department was necessary in order to get the best results from the local organization.

J. W. Luke (A. T. & S. F.) expressed the opinion that some roads are not keeping cars in such fit condition at the present time and the standard of equipment maintenance would not be improved unless the burden of repair work could be distributed among all the roads. From the year 1917 to 1919 the Santa Fe's expenditure for repairs to foreign cars rose from $1,690,000 to $7,700,000, an increase of 355 per cent. Mr. Luke advocated the reinforcement of wooden cars with steel channel center sills and stated that the cost of maintenance of cars so improved compared favorably with modern equipment.

C. Wymer (C. & E. I.) mentioned that sometimes the equipment is designed with no thought of future repairs and the replacement of minor parts necessitates expensive dismantling. Such construction inevitably increases the cost of repairs. In the course of the discussion Mr. Sillcox elaborated on some of the points brought out in the paper. To emphasize the necessity for retiring cars of wooden construction, he quoted statistics showing that 76 per cent of the cars damaged in service were cars with wooden underframes. The failures were distributed as follows: draft gear 63 per cent, knocked off center 14 per cent, end frame failure 14 per cent, cornered 9 per cent.

SHOP PRACTICE

SHOP PRACTICE AT TRANSCONA

BY S. LEWIS
General Foreman Blacksmith, Canadian National Railways

The bulldozer has contributed greatly toward the present high efficiency of the railway blacksmith shop, and can be used for a variety of work other than that for which it was originally designed.

When a die or tool is considered, the first thing to be decided is whether or not it can be made to pay, and if so,

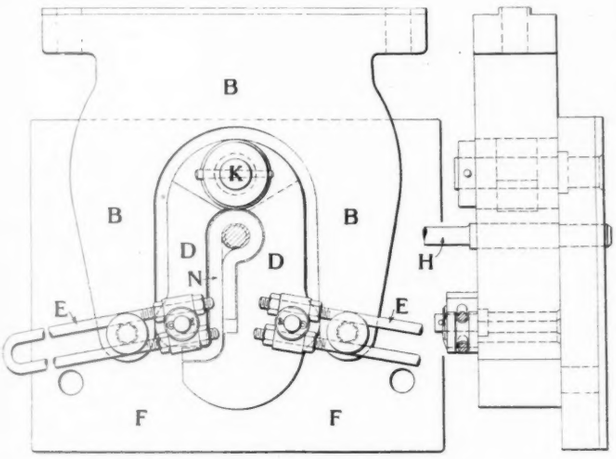


Fig. 1—Arrangement of Dies for Forming Hinge Butts

how much. The answer to this question often involves very many others, but can generally, if not always, be resolved into computations based on the number of pieces to be made, and the probable cost of labor per piece when made with

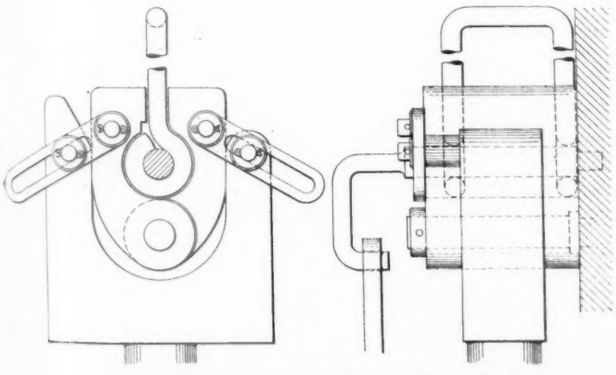


Fig. 2—Dies for Forming Brake Hanger Eyes

and without a die, and also the cost of the die, including maintenance.

One reason in favor of dies is the duplication of pieces when such pieces are made standard, and are subject to great wear and tear. Another reason is accuracy, which can only be attained by the use of such dies. There are certain classes of work which could not be finished at all within the limits of uniformity and accuracy demanded if dies of some sort were not used.

Typical examples of dies which have been used successfully on this class of machine in the Transcona shops of the Canadian National Railways are shown in the illustrations.

Fig. 1 is a compound arrangement intended to form apron hinge butts for Hart cars, with which dies thousands of hinges were successfully formed in one operation. The moveable head *B* takes the form of a *U* shape; attached to the head are two adjustable links *EE*, which cause the two inner arms *DD* to swing open. These two arms are closed by the forward movement of the *U*-shaped head. The swing arms *DD* hinge around the pin *K*, which is fastened to the plate *F* and is bolted to the table of the machine.

The arms, when forming the hinge butt *N*, swing around

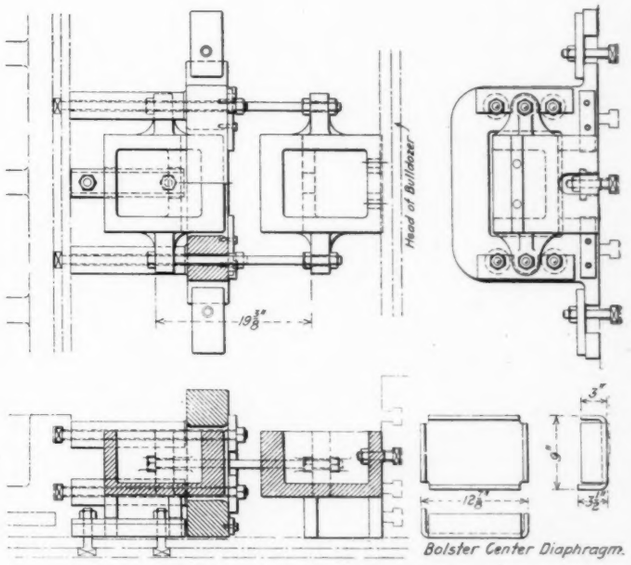


Fig. 3—Dies for Forming Bolster Diaphragms

the adjustable pin *H*, which can be pulled out, and with a few taps of the hand hammer the hinge falls off. All these parts are made from mild steel and very little machine work is necessary.

The economy of this arrangement is obvious and all that is required to form a variety of hinges are the swing arms, several sizes of which can easily be adapted to the one arrangement.

In designing dies of this nature a great deal depends on the character of the work to be done. To insure an easy movement of members with a minimum strain and a maximum formation of parts to be produced, the dies should

be made as light as is consistent. Care should always be taken when planning tools of this character so that the work may easily and accurately be located in order to prevent mistakes. This will add considerably to the efficiency of the operator.

Fig. 2 is an arrangement similar to Fig. 1. This arrangement is assembled on an air bulldozer and has served a great purpose in the pioneering days of the transcontinental road. Brake hangers are made on this machine in two heats and two operations. This die bends both eyes of the hanger simultaneously at one operation at a cost of 1½ cents.

A die to form a bolster center diaphragm is shown in Fig. 3, assembled on a 150-ton hydraulic bulldozer. The diaphragm plates are 4-in. by ½-in. by 1 ft. 5⅜-in. and are partly heated. The backward stroke of the machine releases the pieces from the dies after forming them as shown in the illustration.

Fig. 4 is an example of a simple drill jig used at the Transcona shop to drill holes in coupler pins. A cover of the simplest design contains the guide bushings, which are changeable to suit whatever drillings are required and can handle a variety of such work with great rapidity. The bushing holder can be raised or covered to suit different diameters of work. Both *V* blocks in which the work rests are adjustable, by means of the screws, for different lengths of pins and lend themselves well to a variety of work of all descriptions. It also provides a clamping device, which is very essential to keep the work in position while being drilled. It is simple, efficient, and a characteristic example of an adjustable type of jig.

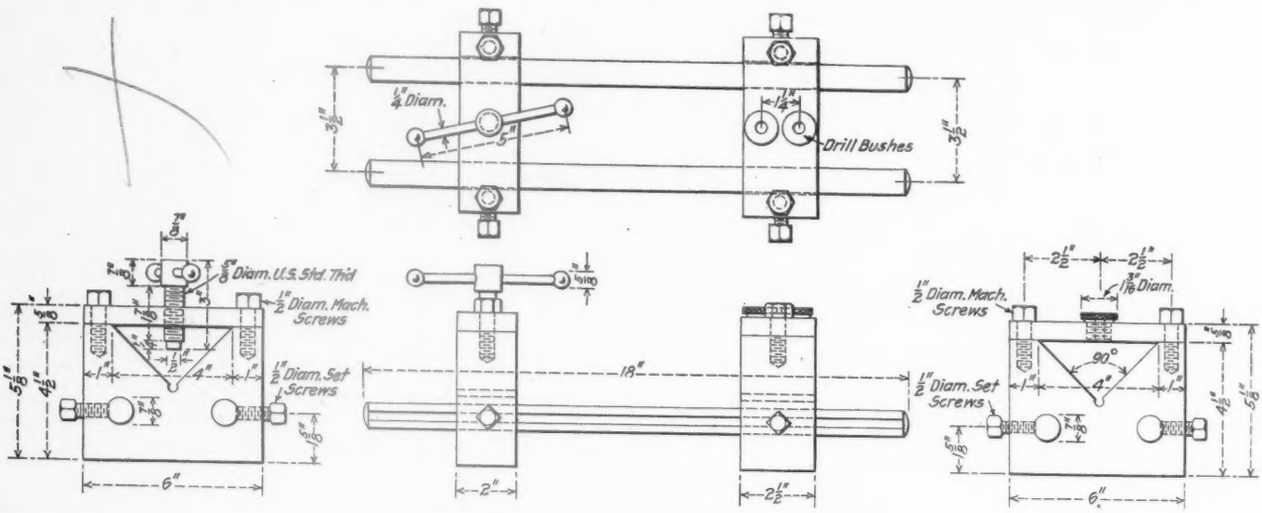
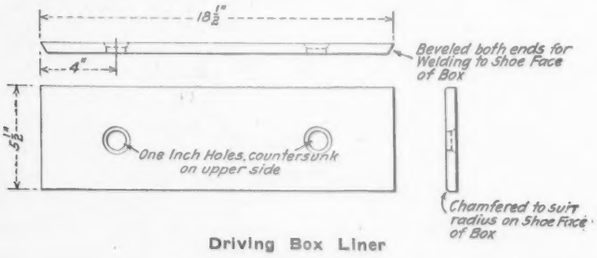


Fig. 4—Drilling Jig for Drilling Holes in Coupler Pins

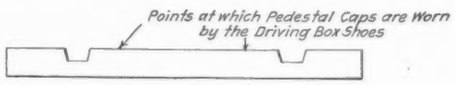
LINERS FOR DRIVING BOXES AND PEDESTAL CAPS

BY A. W. CONWAY

When the shoe faces of driving boxes have become worn below the standard limits by wear and repeated facings, it has been the usual practice to have dovetailed slots cut lengthwise in the shoe face and then pour them with bronze. An improved method of renewing the shoe face is to electrically weld on steel plate liners of suitable thickness to replace the amount the box is worn, making a more durable liner than the bronze. By making the liner of suitable thickness it need only by skinned off when planing it, thus reducing machine work to a minimum. When the bronze liners were used it was necessary to pour an excessive amount, as it was difficult to gage just the proper amount to pour, so there was usually an inch, more or less, to plane off. This new method saves the work of dovetailing to hold the bronze, the time necessary to melt and pour the bronze, and we have a bronze shoe wearing against a steel pedestal jaw on one side and against the steel box liner on the other side, which is far better than bronze against bronze. The holes are placed about four inches from the ends, as the only time when the liner is likely to tear away is during the planing.


18½"
Beveled both ends for Welding to Shoe Face of Box
4"
5½"
One Inch Holes, countersunk on upper side
Chamfered to suit radius on Shoe Face of Box

Driving Box Liner



Pedestal Cap Re-Lined by Welding

It has also been common practice when pedestal caps are worn by the movement of the shoes, to true up the worn surface on a shaper, and then drill and tap the pedestal cap to secure on it a liner of a thickness that will make it flush with the unworn surface of the cap. This worn surface can be built up by the acetylene process and then hammered, making a very neat job, which is far superior to the older method of renewing the bearing surface.

Check Leaks in Welding Apparatus.—Never permit the slightest leak to go unchecked in a welding or cutting apparatus. An oxygen leak is expensive, and an acetylene leak is not only expensive but dangerous. Slight leaks in the hose or connections can be detected by shutting off the regulator valves and closing the cylinder valves, and noting how long the pressure holds up in the pressure gages. If the pressure falls, hunt for the leak.—*Autogenous Welding.*

STEEL TREATERS' SOCIETY CONVENES

Modern Shop Practice and Equipment for Heat Treatment of Cutting Tools and Forgings Discussed

THE American Steel Treaters' Society held its first convention at the Seventh Regiment Armory, Chicago, September 23-27. This organization which was formed in September, 1918, for the study and development of the art of heat treating steel, now has a large membership with chapters in nine cities. Many railroad men have become identified with the society and it is planned to give special attention to problems in which the railroads are interested. The convention was opened with addresses of welcome by H. H. Merrick, president of the Chicago Chamber of Commerce, and by the acting president of the society, T. E. Barker of the Miehle Printing Press & Manufacturing Company. At the later sessions a large number of subjects were discussed. Some of the papers are not available, but abstracts of two having direct application in railroad shop practice are given below and others will be published in future issues.

TYPES OF PYROMETERS AND THEIR USES

BY RICHARD P. BROWN
President, The Brown Instrument Company, Philadelphia, Pa.

Greater progress has been made during the past ten years in the use of pyrometers than was made in the 200 preceding years during which pyrometers were known and used to some small extent. The old methods of measuring temperature by the expansion or fusing points of clay, by the expansion or contraction of metals, and by numerous other means, have largely been eliminated today and there are practically only two methods of measuring high temperatures. The thermo-electric pyrometer embraces either a thermo-couple inserted directly in the heat, or in the form of a radiation pyrometer with the thermo-couple heated by the furnace rays; second, the optical pyrometer, in which a color comparison of an incandescent body and the steel under treatment is made. The optical pyrometer is used only portably, as this instrument is not suitable for permanent installation or for automatically recording temperature. It is used quite extensively where it is necessary to focus on a particular piece of steel in a furnace to secure its temperature, or where excessively high temperatures are measured, around 3,000 deg. F. or 1,600 deg. C., where a thermo-electric pyrometer is not suitable.

THERMO-ELECTRIC PYROMETERS

A thermo-electric pyrometer consists of a thermo-couple, a measuring instrument, and the leads connecting the thermo-couple and the meter. The thermo-couple is formed of two dissimilar metals, usually drawn into wire and with one pair of ends twisted together. When this junction is heated, it generates a small current of electricity which can be measured on a milli-voltmeter.

A thermo-couple produces current, dependent on the temperature of the twisted junction extending into the furnace, known as the hot end, and the opposite end outside the furnace, known as the cold end or cold junction. It is at these ends that the leads running to the meter are joined to the thermo-couple. In accurately measuring temperature with a thermo-couple it is, therefore, essential that the cold junction be maintained at a known fixed and uniform temperature, which may be 75 deg. F. or any other temperature. If the cold junction of a thermo-couple is at 75 deg. F. and the hot junction in the furnace is at 1,400 deg. F., the actual millivoltage generated is proportioned to the difference in temperature between the hot end and the cold end of the thermo-couple, equivalent to 1,325 deg. F. If we heat this cold junction to 100 deg. F. we will then only have a millivoltage produced by the thermo-couple equivalent to the difference in temperature of 1,300 deg. F. instead of 1,325 deg. F., as previously cited.

The effect of heating the cold junction of a base metal thermo-couple is such that with a rise in temperature of the cold junction of 25 deg. F. the instrument will read approximately 25 deg. low. With a platinum thermo-couple this error is approximately one-half. In other words, with a platinum couple, the error would amount to only approximately 12 deg. F. for a rise in temperature of the cold junction of 25 deg. F. above normal.

In the use of any thermo-electric pyrometer it is essential that this point be realized, because far too many thermo-electric pyrometers are still in use today with the old junction of the thermo-couple located high above a furnace and subject to constant changes in temperature and to probably a normal temperature of not less than 200 deg. F.

Assuming that the pointer on the instrument is set at 75 deg. F., such an instrument is actually reading 125 deg. too low. Of course, if the user of the instrument only realizes this fact he will set the pointer of his instrument for the proper cold junction temperature 200 deg. F. instead of that usually adopted in supplying the pyrometer, 75 deg. F.

All modern pyrometers are equipped with zero adjusters which permit of setting the pointer to any desired cold junction temperature and this point can be readily taken care of. Unfortunately in the case where a thermo-couple is located just above the furnace, when the furnace is first started up, the temperature of the thermo-couple inside might attain 1,400 deg. F. and the cold junction outside will have only reached 100 deg. F.; after the furnace has been run six hours, the heat radiation from the crown of the furnace may be such that the cold junction temperature will reach 200 deg. F. In consequence, the pyrometer is reading 100 deg. lower than it did formerly for exactly the same temperature in the furnace. In consequence, the operator in order to make the pyrometer read the desired temperature, 1,400 deg. F., is actually carrying 1,500 deg. F. in the furnace.

COLD JUNCTION COMPENSATION

There are a number of ways in which this source of error due to changes in temperature of the cold junction of the thermo-couple are overcome. First, compensating leads, as they are called, consisting of material the same as that forming the thermo-couple, which will remove the cold junction to some distant point where the temperature will be constant. These compensating leads can be selected of material the same as the thermo-couples or of the other alloys which will offset the effect of change in temperature at the cold end of the thermo-couple.

There are several ways in which we can further reduce this possible error. First, we can run the compensating leads into a pipe driven into the ground for some 10 ft. and at the bottom of the pipe we make our junction with the copper leads running to the instrument. The cold junction is now in the ground where the changes from winter to summer under usual conditions vary 5 deg. F. Where precautions are taken this is an excellent method of maintaining a constant cold junction temperature.

Another common method is to place the cold end of the compensating leads in a compensating box, which consists of a thermostat and lamps or heating units. By means of

the thermostat it is possible to maintain any desired temperature usually up to 150 deg. F. within a limit of + or — 2 deg. F. The ordinary compensating box is designed to take care of as many as 20 thermo-couples, which are led into the one compensating box and this affords an easy method of maintaining a constant temperature.

The compensating leads from the thermo-couples can also be run to the instrument, which may be located in the room subject to variation in temperature from probably 70 to 100 deg. F. from winter to summer. In this case it is possible to have an error of as much as 30 deg. F.

Thermo-electric pyrometers are now supplied with automatic compensating means at the instrument so that, provided the compensating leads are run to the instrument, automatic compensation takes place to overcome changes in temperature at the instrument itself. This compensation can be readily incorporated in the thermo-electric pyrometers through a shunt of large temperature coefficient, which will be materially affected with atmospheric changes in temperature.

BASE METAL THERMO-COUPLES

I have referred previously to the use of thermo-couples formed of base metal and of platinum wire. Base metal thermo-couples are almost universally used for measuring temperatures to 2,000 deg. F. or 1,100 deg. C. These base metal thermo-couples for temperatures up to 1,200 deg. F. or 650 deg. C. are usually formed with one wire of constantan, a nickel copper alloy, and the other a pure iron. This form of thermo-couple is advantageous for use in a reducing atmosphere within the above temperature limits. For temperatures above 1,200 deg. F. up to 2,000 deg. F., equivalent to 650 deg. C. or to 1,100 deg. C., a thermo-couple formed of one wire of 90 per cent nickel and 10 per cent chrome and the other wire of 98 per cent nickel with balance manganese, silicon and aluminum, would give the most satisfactory service.

Base metal thermo-couples as supplied today are furnished in all diameters from .01 in. up to ¼ in. in diameter; sensitive thermo-couples of wire .01 in. in diameter can be used experimentally to advantage in testing the temperature of the surfaces of metal, particularly at moderate temperatures, whereas thermo-couples formed of wire ⅛ in. or ¼ in. in diameter are better suited for constant service in large heat-treating furnaces.

PLATINUM THERMO-COUPLES

Where we have to measure temperatures from 2,000 deg. F. or 1,100 deg. C. up to a maximum of 3,000 deg. F. or 1,000 deg. C., it is best to use a platinum rhodium thermo-couple, one wire being of pure platinum and the other platinum 90 per cent and rhodium 10 per cent. The wires forming this thermo-couple are usually .02 in. in diameter. A platinum rhodium thermo-couple gives very satisfactory life even under severe service at temperatures up to 2,500 and 2,600 deg. F., provided the wires are suitably protected from the gases with a tube of porcelain or silica, which is impervious to gases. These tubes are in turn protected with a tube of graphite, carborundum, fire brick or other suitable material which serves to protect the fragile porcelain or silica tube from mechanical injury and introduces a slight lag to prevent breakage through contraction and expansion due to sudden changes in temperature.

While it is of the utmost importance to properly protect a platinum rhodium thermo-couple to exclude gases which very actively attack the platinum, it is equally desirable to properly protect a base metal thermo-couple if maximum life is to be secured. The usual method of protecting a thermo-couple for temperatures up to 1,400 deg. F. (750 deg. C.) or below, is to use a common wrought iron pipe with the lower end plugged or welded. The life of common wrought iron pipe can be increased to some extent by calorizing, a process of impregnating the pipe with an aluminum oxide.

A material increase in the life of base metal thermo-couples for temperatures above 1,400 deg. F. or 750 deg. C. is secured by the use of protecting tubes of nickel chromium or of a special alloy. The nickel chromium tubes withstand to a satisfactory extent normal use in heat treating furnaces where the temperature does not exceed 1,600 deg. F., but for the most common conditions, and where maximum life is secured this special alloy tube is giving the best results.

To insulate the wires forming a thermo-couple from each other and from the protecting tube, it is common practice to use beads of porcelain or lavite, which are the most satisfactory for this service. Formerly asbestos tubing or string was used to insulate each wire and this was painted with a solution of sodium silicate and carborundum, but this form of insulation rapidly disintegrates at temperatures above 1,000 deg. F. The porcelain or lavite insulation is most certainly to be recommended.

STANDARDIZED VOLTAGE FROM THERMO-COUPLES

A platinum rhodium thermo-couple, on account of the care taken in the refining of the precious metals and the proper alloying, can be reproduced continuously with the same millivoltage. As new ingots are cast every few years from which this wire is drawn, it has been possible to carefully duplicate these ingots so that the millivoltage is reproduced within some 5 deg. F. of the millivoltage produced by a previous lot.

With base metal thermo-couples it has been extremely difficult to select wires which will accurately reproduce the standard millivoltage of a certain base metal thermo-couple. It seems that the limit in this respect is approximately 15 deg. plus or minus or a total possible error of 30 deg. F. We have, however, made some progress through special care in selecting wire producing the desired millivoltage, and it is possible today to supply wire for thermo-couples with an accuracy within 10 deg. F. plus or minus.

Where extreme accuracy is required it is possible to shunt the thermo-couples to a definite or standard millivoltage by reducing the voltage produced by the thermo-couple by some two millivolts. With this method it is possible to standardize any thermo-couple with extreme precision and an accuracy within plus or minus 4 deg. F. can be easily obtained.

A shunted thermo-couple can be used to advantage where the immersion of the thermo-couple in the furnace does not exceed 18 in. For unusual immersions where the thermo-couple must project, for example, several feet inside the furnace, the unshunted thermo-couple is preferable. Where the shunted thermo-couple is used it has the advantage that it is possible to re-standardize this thermo-couple at any time provided it falls off in voltage. With the unshunted thermo-couples should this occur, it must be either junked or shortened if this is possible.

The shunted thermo-couple has the disadvantage that the shunt may be broken accidentally or through mechanical injury. Both the shunted and unshunted thermo-couples have their advantages and disadvantages and each has its uses.

There are two common methods of measuring the voltage produced by the thermo-couple, the milli-voltmeter method and the potentiometer method.

THE MILLI-VOLTMETER METHOD OF MEASURING TEMPERATURE

The milli-voltmeter method has been in use for a great many years. The original milli-voltmeters were constructed with a movable element swinging in the airgap of a permanent magnet and hung by a fine suspension wire. As a platinum thermo-couple produces some 20 thousandths of a

volt for 3,000 deg. F. and a base metal thermo-couple some 40 thousandths for 3,000 deg. F., the usual temperature scale, the internal resistance of an instrument is dependent on the type of thermo-couple used and the voltage is consequently available.

These suspension type instruments which were largely made in France, England and Germany some 20 or more years ago, had an internal resistance of 300 to 600 ohms with a platinum thermo-couple with full scale of 20 millivolts. On account of the delicate construction of these instruments and the continual breakage of the suspension wires, certain manufacturers in this country produced a low resistance form of milli-voltmeter pyrometer consisting of the standard form of switchboard or portable milli-voltmeter used with a shunt as an ammeter. This instrument usually had from 3 to 5 ohms internal resistance. While it was true that such an instrument was exceedingly robust and could be handled without likelihood of injury, it was equally true that the accuracy of such an instrument was exceedingly poor on account of the low internal resistance of the instrument. Frequently the total resistance of the thermo-couple and the leads connected to such an instrument might vary from a total of 1 ohm to 2 ohms, affecting the actual readings of the instruments as much as 20 per cent.

If an instrument of this kind was calibrated for a 3-ft. thermo-couple of the usual ⅛-in. wire and it had later to be used with a 4-ft. thermo-couple, unless the instrument was re-calibrated it read 20 deg. F. too low. If the instrument was calibrated from 25-ft. double conductor No. 12 gage copper leads and it had later to be located at a greater distance where 75 ft. of the above leads were required, the instrument read some 18 deg. F. too low. Under such conditions it was absolutely impossible to secure any precision in measuring temperature.

In the past five or six years, high resistance milli-voltmeter pyrometers have been developed with an internal resistance with a platinum couple of as high as 600 ohms or with a base metal thermo-couple as high as 1,200 ohms, which have a standard double pivoted construction used in the ordinary low resistance instrument.

Where an instrument of 600 ohms resistance is used, a change in line resistance from 5 ft. to 500 ft., which is naturally very excessive, will affect the readings of the pyrometer only 4 deg. F. where the scale is graduated to 2,000 deg. F. Any likely change in the length of the thermo-couple has absolutely no effect on the readings of such a pyrometer.

In the last couple of years, instruments have been brought out in which the effect of line resistance can be entirely eliminated by balancing the voltage of the thermo-couples against that of another source of electromotive force such as a dry cell. Usually an adjustable resistance is installed for a total of 15 ohms and any variation in line resistance can be compensated for in this type of instrument up to a total of 15 ohms. After this adjustment has been made, the instrument is direct reading and independent of line resistance.

Exhibit at Convention of American Steel Treaters Society

Messrs. Harrison and Foote of the Bureau of Standards, Washington, have recently hit upon a method of accomplishing this result by using the voltage of the thermo-couple itself. This new instrument requires no dry cell or standard cell as a source of electromotive force. The instrument is similar to the ordinary milli-voltmeter in appearance, with the addition of the small key and resistance knob. The operator has only to read the temperature in the usual way. He presses the key and if the reading is any different from that which was previously observed, he turns the resistance knob until there is no change, whether the key

is depressed or not. The instrument has then been adjusted for line resistance, which may be any amount whatsoever up to 15 ohms, equivalent to many miles of copper leads. What little temperature coefficient exists in the ordinary high resistance milli-voltmeter is balanced out in this instrument. Accuracy in calibration of an instrument of this kind can be guaranteed within 1/10 of a milli-volt equivalent on the base metal scale of 4 deg. F.

THE POTENTIOMETER METHOD OF MEASURING TEMPERATURE

The potentiometer method of measuring the voltage produced by a thermo-couple has been quite extensively adopted in the past six or eight years where extreme precision is required. The potentiometer method differs from the milli-voltmeter method in that the milli-voltmeter uses the current produced by the thermo-couple to deflect the instrument. The potentiometer opposes the current of the thermo-couple to that of a dry cell and the dry cell current, equivalent to that of the thermo-couple, is measured in the usual way.

A galvanometer is used to indicate the point at which no current is flowing, and when the pointer on the galvanometer indicates zero, the voltage of the dry cell is equivalent to that of the thermo-couple. The line resistance from the dry cell to the galvanometer is exceedingly small and constant. When the thermo-couple voltage has been opposed to the voltage of the dry cell and balanced, the actual measurement is that of the dry cell circuit. Hence this measurement is entirely independent of the resistance of the circuit including the thermo-couple, lead wires and galvanometer resistance.

The potentiometer can be used with any length of leads desired, and the indications are entirely independent of line resistance or changes in resistance due to atmospheric changes in temperature along the leads. The potentiometer has a disadvantage as compared with the milli-voltmeter method of temperature measurement in that some outside source of current, a dry cell and standard cell, for example, are necessary as a source of current and the dry cell must be replaced from time to time. The standard cell likewise is liable to injury if subjected to temperatures below 40 deg. or above 104 deg. F. and the standard cells must be checked occasionally.

RECORDING PYROMETERS

Potentiometer pyrometers are available in recording form, in which the mechanism automatically balances the voltage of the cell against that of the thermo-couples, and in this instrument the records are automatic and no hand balancing is required.

In either the milli-voltmeter or in the potentiometer type, recording pyrometers are available to plot a continuous record of the temperatures on a chart daily, weekly or monthly, as desired. The recording pyrometers are supplied either to make a single record on a chart, or with two or more galvanometers side by side making individual records on one recording sheet. Multiple recording pyrometers are also available incorporating a switching mechanism, which alternately connects the various thermo-couples to the galvanometer or milli-voltmeter in a recording instrument, and many records can be secured on one chart. This is a distant advantage in certain cases.

Where a recording instrument operates on the milli-voltmeter method, the frictionless type of recorder is required, and the pointer is depressed only momentarily at intervals on the recording chart. In the potentiometer type of recorder, sufficient power is available from the motor operating the instrument to imprint a record directly on the recording chart.

SIGNALING PYROMETERS

Automatic signaling pyrometers have been used for some years in the larger heat-treating plants where it is desirable that the operator should not decide, but should be signaled by lights, as to whether the temperature is within the correct limits. For some years it has been common practice to install a central indicating pyrometer with switchboard, and by means of three colored lights at each furnace, usually red, white and green, to signal from the central station whether the temperature is too low, correct, or too high. Usually 25 deg. F. is considered a limit within which the temperature should be maintained.

The white light burns when the temperature is correct. If the temperature drops below, the green light glows, or if it rises above the desired temperature the red light burns. A step farther is the automatic signaling of the temperature by an automatic signalling pyrometer which can be incorporated in the standard form of milli-voltmeter pyrometer giving instantaneous readings.

AUTOMATIC TEMPERATURE CONTROL PYROMETERS

The day when the furnace temperatures will be accurately controlled automatically is coming very rapidly and notable progress has been made in this respect during the last few years. The application of automatic control pyrometers to electric furnaces is a comparatively easy problem, as automatic switches can easily be operated by a solenoid which can in turn be operated by the same contact device in the pyrometer as used in the signaling instrument. We have applied automatic temperature control to electric furnaces most successfully and some 100 electric furnaces to my knowledge are being controlled automatically at present. This control may be secured by the opening and closing of the main circuit or line, or by cutting in and out a small portion of the available current.

Automatic control of gas fired furnaces is a little more difficult, as a gas valve to be tight and not leak under continual operation, must be well packed and considerable power is required to operate the valve. We have, however, by the use of powerful solenoids or by motor operated valves, been able to overcome this, and we have a number of gas-fired furnaces of large dimensions which are automatically controlled.

There is no question that within the next year or two the automatic control of furnace temperatures will be very generally adopted wherever a constant temperature is to be maintained and it is desirable to eliminate the human element and hand control.

THE PART PYROMETERS PLAY IN STEEL TREATMENT

Many are not aware of the part pyrometers play in steel treatment from the smelting of the iron until the finished product. Let us take a part made from high grade alloy steel. First in the blast furnace where the iron is smelted; the hot blast temperatures and the temperature of the escaping gases from the furnace are accurately controlled by thermo-electric pyrometers. Next, the open hearth furnace where the steel is refined. Temperatures are very largely controlled in these furnaces by installing a platinum thermo-couple in the slag pocket or the gases from the checker brick. A very satisfactory record can be secured on a recording pyrometer of the working of the open hearth furnaces in this indirect manner. Optical pyrometers are also used to focus on the molten steel in the furnace or on the steel in pouring. This form of pyrometer has not come into general use.

The forging of steel carried on in forging furnaces at a temperature of around 2,300 deg. F. is accurately controlled with the aid of thermo-electric pyrometers, using platinum thermo-couples with special tubes.

The annealing, hardening, re-heating and the quenching temperatures are realized by everyone to be of the utmost importance and should be accurately controlled with pyrom-

eters. Where oil or water is used for quenching, recording thermometers or resistance thermometers are applied to advantage.

While we are continually striving to improve pyrometers and to design these instruments to better meet each requirement, our efforts are a failure provided we cannot educate the users of pyrometers in how to use and care for them.

The best of pyrometer installations often give unsatisfactory results simply because it was assumed that when pyrometers were installed that the steel in some miraculous manner would come out perfectly heat-treated without any attention whatsoever. The pyrometers were apparently supposed to be infallible, and while a watch has to be wound and adjusted occasionally the pyrometer should require no such attention. There are no pyrometers produced today which do not require some attention.

If you install pyrometers, take the time to make a little study of how the instruments operate, how they can best be installed, and how they are to be cared for after they are in use in your plant. If you have quite a number of furnaces and a considerable pyrometer installation, place a man in charge of the instruments who has been first instructed in the information anyone should have to handle such a job. Do not take an office boy to look after your pyrometer equipment as I have seen so often done. A first class pyrometer equipment will pay for itself time after time during the year, and will be of infinite benefit to the user provided, first, it is properly designed to meet the conditions; second, it is properly installed; third, it is properly understood and cared for.

PRACTICAL INFORMATION CONCERNING HIGH SPEED STEEL

BY ROY C. McKENNA
President, Vanadium-Alloys Steel Company, Latrobe, Pa.

The manufacturer of high speed steel, knows and appreciates the troubles and difficulties that may sometimes arise in the heat treating of his product. The manufacturer's aim is to make a uniform high speed steel which will best meet the requirements of the average machine shop on general work, and at the same time allow the widest variation in heat treatment to give desired results.

High speed steel is one of the most complex alloys known. A representative high speed steel contains approximately 24 per cent of alloying metals, namely: tungsten, chromium, vanadium, silicon, manganese, and in addition there is often found cobalt, molybdenum, uranium, nickel, tin, copper and arsenic.

COMPOSITION OF HIGH SPEED STEEL

The selection of a standard analysis by the manufacturer is the result of a series of compromises between various properties imparted to the steel by the addition of different elements. There is a wide range of chemical analyses of various brands of high speed steel. Although there are being manufactured as high speed steel, brands that do not come within the standard of what is commercially known as high speed steel, there are certain well defined limits to the contents of certain elements.

The steel, to be within the range of generally accepted analysis should contain over 16 per cent and under 20 per cent tungsten. If of lower tungsten content it should carry proportionately more chromium and vanadium. Further discussion in this paper is confined to high speed steels containing approximately 18 per cent tungsten.

The combined action of tungsten and chromium in steel gives to it the remarkable property of maintaining its cutting edge at relatively high temperature. This property is commonly spoken of as "red-hardness." The percentage of tungsten and chromium present should bear a definite relationship to each other. Chromium imparts to steel a hardening property similar to that given by carbon, although to a less degree. The hardness imparted to steel by chromium is accompanied by brittleness. The chromium content should be between 3½ and 5 per cent.

Vanadium was first introduced in high speed steel as a "scavenger," thereby producing a more homogeneous product, of greater density and physical strength. It soon became evident that vanadium used in larger quantities than necessary as a scavenger, imparted to high speed steel a much greater cutting efficiency. Recently, no less an authority than Professor J. O. Arnold, of the University of Sheffield, England, stated that "high speed steels containing vanadium have a mean efficiency of 108.9, as against a mean efficiency of 61.9 obtained from high speed steel without vanadium content." A wide range of vanadium content in high speed steel from ½ to 1½ per cent, is permissible.

An ideal analysis for high speed steel containing 18 per cent tungsten is a chromium content of approximately 3.85 per cent; vanadium .85 per cent to 1.10 per cent and carbon between .62 and .77 per cent.

INGREDIENTS WHICH ARE DETRIMENTAL

Sulphur and phosphorus are two elements known to be detrimental to all steels. Sulphur causes "red-shortness" and phosphorus causes "cold-shortness." The detrimental effect of these two elements counteract each other to some extent but the content should be not over .02 sulphur and .025 phosphorus. The serious detrimental effect of small quantities of sulphur and phosphorus is due to their not being uniformly distributed, owing to their tendency to segregate. The contents of manganese and silicon are relatively unimportant in the percentage usually found in high speed steel.

The detrimental effects of tin, copper and arsenic are not generally realized by the trade. Small quantities of these impurities are exceedingly harmful. These elements are very seldom determined in customers' chemical laboratories and are somewhat difficult for public chemists to analyze for.

In justice to the manufacturer of high speed steel, attention should be called to the variation in chemical analyses between the best of laboratories. Generally speaking, a steel works laboratory will obtain results much nearer true and accurate than is possible by a customer's laboratory, or public chemist. This can reasonably be expected for the steel works' chemist is a specialist, analyzing the same material for the same elements day in and day out.

METHOD OF MANUFACTURE IS IMPORTANT

The chemical composition of steel for any purpose is a basic consideration and must be such as will meet the requirements, but the quality of the steel does not depend wholly upon the chemical composition. Assuming the chemical composition to be within the permissible limits, the quality depends upon local conditions surrounding its manufacture. If the quality of steel were entirely dependent upon the chemical composition and not influenced by its working and handling in accordance with tool steel practice, the tool steel industry would be unable to exist.

The successful manufacture of high speed steel can only be obtained by those companies who become specialists. The art and skill necessary in the successful working of such steel can be attained only by a man of natural ability in his chosen trade, and trained under the supervision of experts. To become an expert operator in high speed steel in any department of its manufacture, it is necessary that the operator works almost exclusively in the production of such steel.

As to the heat treatment of high speed steel, it is customary for the manufacturer to recommend to the user a procedure that will give to his steel a high degree of cutting efficiency. The recommendations of the manufacturer should be con-

servative, embracing fairly wide limits, as the tendency of the user is to adhere very closely to the manufacturer's recommendation. Unless one of the manufacturer's expert service men has made a detailed study of the customer's problem, the manufacturer is not justified in laying down set rules, for if the customer does a little experimenting he can probably modify the practice so as to produce results that are particularly well adapted to his line of work.

GENERAL PRACTICE IN HARDENING

It is not the writers' intention to make any definite recommendations as to the heat treating of high speed steel by the users. It is recognized that such steel can be heat treated to give satisfactory results by different methods. It is, however, believed that the American practice of hardening and tempering high speed steel is becoming more uniform. The trend of American practice for hardening high speed steel is towards the following: First: Slowly and carefully preheat the tool to a temperature of approximately 1,500 deg. F., taking care to prevent the formation of excessive scale. Second: Transfer to a furnace, the temperature of which is approximately 2,250 deg. to 2,400 deg. F., and allow to remain in the furnace until the tool is heated uniformly to the above temperature. Third: Cool rapidly in oil, dry air blast, or lead bath. Fourth: Draw back to a temperature to meet the physical requirements of the tool, and allow to cool in air.

It was not very long ago that the desirability of drawing hardened high speed steel to a temperature of 1,100 deg. F. was first pointed out, and it is indeed encouraging to learn that comparatively few treaters of high speed steel have failed to make use of this fact. Many steel treaters at first contended that the steel would be soft after drawing to this temperature and it is only recently, since numerous actual tests have demonstrated its value, that the old prejudice has been eliminated.

With an understanding of some of the difficulties inherent in the manufacture of high speed steel, I will try to give you the justification of some of the trade practices and customs which have been generally accepted.

DISCUSSION OF TRADE PRACTICES

High speed steel should be delivered only in the annealed condition because annealing relieves the internal strains inevitable in the manufacture and puts it in vastly improved physical condition. The manufacturer's inspection after annealing also discloses defects not visible in the unannealed state.

The only true test for a brand of high speed steel is the service that it gives by continued performance month in and month out under actual shop conditions.

The value of the file test depends upon the quality of the file and the intelligence and experience of the person using it. The file test is not reliable, but in the hands of an experienced operator, gives some valuable information. The manufacturer of small tools from high speed steel sometimes carries the file test to extremes. Almost every steel treater knows of numerous instances where a lathe tool which could be touched with a file has shown wonderful results as to cutting efficiency.

The practice of buying high speed steel by brand names is justifiable. The guarantee behind high speed steel is the standing and reputation of the manufacturer, who should maintain in his employ metallurgists and experienced service men who will be ready at any time to heat-treat and demonstrate to the buyer's satisfaction that the product furnished will meet any reasonable requirements. The customer's specifying the chemical, physical or metallurgical properties relieves the manufacturer of his responsibility as to quality. Quality is not dependent upon the chemical composition and poor high speed steel can be made within any limits of chemical content that could be commercially met by a manufacturer of best quality high speed steel. In purchasing high speed steel by brand name the buyer places responsibility for performance clearly with the manufacturer. The specifying of phyiscal, chemical or metallurgical limits by the buyer would lead to endless controversy and would positively retard, in fact, completely arrest the progress of the industry.

The manufacturers of high speed steel should co-operate to the extent of submitting upon request rejection limits as to chemical content of those elements which vitally affect the steel treater's work. It is not desirable that the manufacturer's rejection limits be published broadcast. The buyer has the right to demand that high speed steel purchased by him should be within the generally accepted analysis of high speed steel. Chemical composition is a basic consideration, but the quality is dependent upon many other factors, the most important of which is the human element. No steel treater can question the fact that the results obtained from heat-treating depend upon the operator. The operator will use all modern appliances, such as pyrometer, automatic temperature control, quenching machines, etc., but the results obtained depend upon his individual experience and skill. The manufacture of tool steel is and will continue to be a handicraft industry.

Modern tool steel practice has changed from that of the past, not by the use of labor-saving machinery, but by the use of scientific devices which aid and guide the skilled craftsman in producing a steel of higher quality and greater uniformity. It is upon the intelligence, experience and skill of the individual that the quality of tool steel depends.

ELECTION OF OFFICERS

The following national officers of the society were elected: president, T. E. Barker, Miehle Printing Press & Manufacturing Company, Chicago; first vice-president, E. J. Janitzky, Illinois Steel Company, South Chicago; second-vice-president, D. K. Bullens, Cann & Saul, Royersford, Pa.; secretary, Arthur G. Henry, Illinois Tool Works, Chicago; treasurer, A. F. Boissoneau, William Ganschow Company, Chicago; directors, H. G. Weidenthal, James H. Herron Co., Cleveland, Ohio; A. F. MacFarland, Vanadium-Alloys Steel Company, Latrobe, Pa.; J. Fletcher Harper, Allis-Chalmers Company, Milwaukee, Wis., and J. O. Pollak, Pollak Steel Company, Cincinnati, Ohio.

On September 25 a banquet was held at the Morrison Hotel which 620 members and guests attended. Addresses were delivered by J. W. O'Leary of A. J. O'Leary & Son, Chicago; Doctor H. Marion Howe, consulting metallurgist and scientific attaché to the American Peace Commission; and Professor J. W. Richards, professor of metallurgy at Lehigh University.

Air Power for Driving Locomotives.—A recent issue of the New York Times contains a special dispatch from Rome describing an invention for driving locomotives by air power, which has been submitted to the Italian State Railways by a young Italian engineer. The secret of the invention lies in a new system of compressed air by which big central tanks may store enormous power to be distributed to "fuel" stations along the railway lines by strong pipes. Steam is superseded, coal, water power and electricity are no longer needed. The inventor claims his system is cheaper and its adapatability to railway systems quicker than any other existing. Steam locomotives can be used almost without changes, only the coal tender must be converted into an air tank. In the new scheme the main expenditure is for the building of big plants for compressing air and the laying of pipes, all of which is said to be vastly cheaper than electrical installation. It is not stated where the compressor power is to come from.

SETTING LOCOMOTIVE VALVES

Instructions for Setting Walschaert, Young and Stephenson Gears; Simple Individual Operations

By L. D. FREEMAN

THE railroads are spending considerable money and effort on fuel economy, but at the same time do not pay enough attention to correct valve setting and steam distribution, and frequently by the wasteful use of steam more than offset the economies of efficient steam generation.

There are two reasons why locomotives of the same class in the same state of repairs do not pull the same tonnage at the same speed over the same division. The first reason is different valve events, and the second, enginemen do not have the reverse lever in the proper notch to produce maximum drawbar pull under given conditions. This latter cause was thoroughly investigated by B. B. Milner, engineer motive power, New York Central Lines, and published in the *Daily Railway Age* of June 25, 1919.

To secure more uniform and efficient results, simple instructions have been worked out for valve setting and have had considerable success in use on the Seaboard Air Line.

The object of these instructions for valve setting was to investigate the different valve events possible with the existing parts on each different class of locomotive; to adopt the setting best suited to that class of locomotive; by means of fixed gages to enable any mechanic of ordinary skill not only to set the valves with the least amount of work, but to duplicate the setting on any number of locomotives at any future time; and to so divide the work into simple individual operations that any mechanic could perform the different operations even if he did not possess the skill to do so without definite instructions.

The expert valve setter of 10 or 15 years ago has almost entirely disappeared, due principally to the flat rate for all mechanics of the same craft removing the incentive of extra compensation for diligent study of the art.

Correct valve setting depends on the ability of the valve setter to identify the various defects in the assembling of a valve gear on each locomotive and to make such corrections as are necessary to produce the desired valve events.

Numerous details that had to be worked out do not appear in the instructions, but are described in detail under the heading of each kind of gear.

GENERAL CONDITIONS

Maximum valve travel—In full gear for slide valves and outside admission piston valves, limit the maximum travel

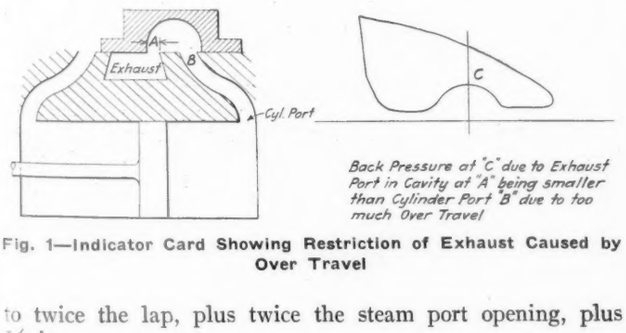

A
Exhaust
B
Cyl. Port
C
Back Pressure at "C" due to Exhaust Port in Cavity at "A" being smaller than Cylinder Port "B" due to too much Over Travel

Fig. 1—Indicator Card Showing Restriction of Exhaust Caused by Over Travel

to twice the lap, plus twice the steam port opening, plus ¼ in.

Many slide valve engines over travel so far that the steam pressure under the lower face unbalances the valve, causing it to lift off the seat and blow through the exhaust. While this occurs only with the reverse lever in full gear, either way, it is a condition that is very difficult to detect.

A more common disturbance caused by the over travel is that the valve moves so far off center that the exhaust cavity partly closes and restricts the exhaust at about half stroke, builds up back pressure and makes an indicator card with a "hump" in the exhaust line as shown in Fig. 1. It was usually claimed that this was due to the exhaust "blowing over" the bridge in the exhaust stand, but that this could not be the cause is evident, since this defect has not been found in all engines using the same design of exhaust stand.

Steam Lap—This should be as large as possible, since the larger the steam lap, the larger the exhaust port opening will be for any given valve travel. For example: with 5/16 in. steam port opening at shortest cut-off, with one inch lap, the exhaust port opening is 1 5/16 in., while if the lap can be 1¼ in. the resultant steam port will be 1 9/16 in., or nearly 20 per cent increase and consequently a "smarter" engine is obtained.

Exhaust Lap—The exhaust lap simply holds the steam later than necessary to get useful work from it, and makes it more difficult to get rid of the exhaust, building up back pressure that offsets any gain in useful work and therefore is not to be recommended.

Exhaust Clearance—At high speeds it is necessary to have the exhaust open earlier to get rid of the steam and stay open later to prevent excessive compression. With slide valves on fast freight engines 1/32 in. will take care of the exhaust. Should any excessive compression occur the slide valve is unbalanced and blows through into the exhaust. With piston valves it is necessary to give about 3/32 in. to protect against excessive compression.

For passenger locomotives, an exhaust clearance of 1/16 in. should be allowed for slide valves and ⅛ in. to 3/16 in. for piston valves, depending on the speed at which the locomotive is to operate.

Maximum Cut-off—Lay out Zeuner valve diagram for each class of locomotive and arrange lap, lead and valve travel so that the maximum cut-off is 85 per cent of the stroke, taking advantage of any chance to increase steam lap with a given travel.

Minimum Cut-off—To prevent excessive strains to the machinery, limit the minimum cut-off to 20 per cent of stroke, handling the throttle to reduce drawbar pull below this limit.

WALSCHAERT GEAR

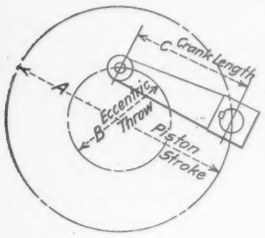
Lead should be limited so that the crosshead is within one inch or less of the end of stroke before the combination lever opens the valve for lead. Limit the lead to ¼ in.

Locomotives having Walschaert valve gear are designed for constant lead at all position of the reverse lever and should be so set unless ordered to be set with variable lead on passenger locomotives. In any valve gear obtaining motion from the crosshead and a crank arm on the main pin, the combination of these two movements gives the desired valve events. Lap and lead travel comes from the crosshead and is in complete control of the valve when the main pin is on either front on back dead center. In this position the crank arm is on the top or bottom quarter and has no control over the valve. The crank arm passing through a given circle *B*, Fig. 2, has full control over the valve at full travel in any position of the reverse lever.

Before attempting to set valves it is first necessary to prove that all parts are in accordance with the drawings for that class of engine.

First Operation—Set the crank correctly as shown in Fig. 2.

Second Operation—Prove the length of the reach rod. Set the reverse lever in vertical position and plumb the



Engine Number New	Engine Number Old	Class	A	B	C
645-649 Constant	46-50 Lead	L-2	28"	15 5/8"	16
645-649 Variable	46-50 Lead	L-2	28"	15 5/8"	16 5/8"
778-787	778-787	L-4	28"	15 5/8"	16"
763-777	763-777	L-4	28"	17 1/2"	17"

Fig. 2

reverse shaft. Measure the true length of the reach rod at *D*, as in Fig. 3.

Third Operation—Prove the length of the radius bar hangers. Place the reverse lever on center with the proper

Fig. 3

length of roach rod. After proving that the lifter arms are parallel, swing the link back and forth and adjust hangers *E* until a still valve is obtained, as in Fig. 4.

It is not necessary to place valve rollers under each engine. All adjustments can be made by trailing with another

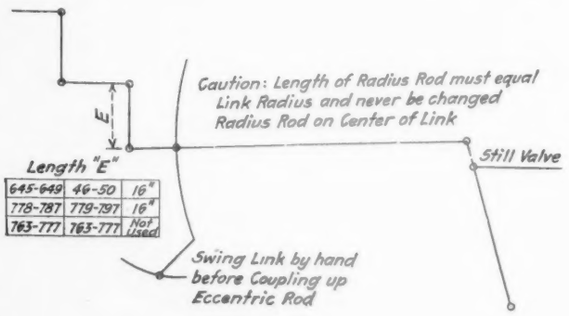

Caution: Length of Radius Rod must equal Link Radius and never be changed
Radius Rod on Center of Link
Still Valve
Length "E"
645-649 46-50 16"
778-787 779-797 16"
763-777 763-777 Not Used
Swing Link by hand before Coupling up Eccentric Rod

Fig. 4

engine. The most common error in valve setting is to attempt to make all changes with one trailing. It is absolutely necessary that the engine be trailed twice, once to adjust the lead and once to adjust the cut-off.

Fourth Operation—Adjust the lead, change the valve rod, place the reverse lever on center and trail the engine; adjust the valve rod to equalize the lead on both sides of the port marks. No further change can be made on the valve rod. The valve rod must be changed before trailing for the cut-off.

Fifth Operation—Adjust the cut-off, change the eccentric rod, trail the engine with the lever at half stroke and equalize the cut-off on the eccentric rod. To find the amount of change, multiply the change desired by the distance from the link center to the center of the eccentric rod pin and divide by the distance from the link center to the center of the link block. See Fig. 5.

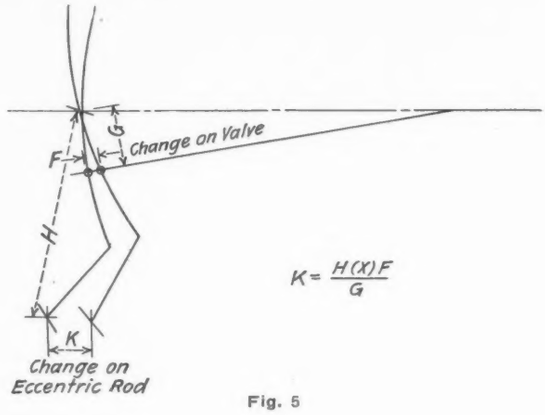


Fig. 5

The method of compiling valve data for engines having Walschaert valve gear is shown in the following table:

Engine class	Max. valve travel, in.	Steam lap, in.	Lead, constant, in.	Exhaust clearance, in.
L-2	6	1 1/8	1/4	3/32
P-1	6 1/2	1 1/8	3/16	3/16
L-5	5 1/2	1	3/16	....
L-4	6 1/4	1 1/8	1/4	3/64
L-4	6	1 1/8	1/4	3/32
P-1	6 1/2	1 1/8	3/16	1/8
H-1	6	1	3/16	....

STEPHENSON GEAR

Back set the saddle pin as in Fig. 6. This is not an exact science, that is, there is no absolute definite point that can be calculated. O. W. Young, formerly valve gear designer for the American Locomotive Company, made extensive ex-

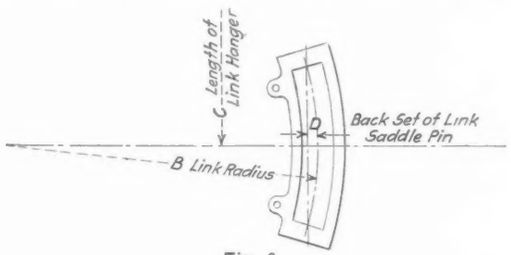


Fig. 6

periments on a full size model and the conclusion reached was that back set calculated in accordance with his formula published in the *Railway Age Gazette,* Mechanical Edition, page 647, December, 1913, was close enough for all practical purposes, but could be varied as much as 1/4 in. without detrimental results. This has been proved by investigation of engines in actual service.

Data Used With Figure 6

Engine class	Reverse shaft, in. A, in.	Top arm B	Link arm C	Rocker arms, in. Valve end	Link end
G-1	9 1/2	23	18	11	9 3/4
G-2	6 1/2	23	17 1/2	11 1/2	10
H	2 1/2	22	15	13 1/2	11 1/4
I-4	1 1/2	18	18	11 1/4	10 1/4
L-5	2 1/4	20	17	11 1/4	10 1/2
L-2	2 1/8	27	18	18 1/2	16 1/2
L-2	2 1/2	27	18	17 1/8	16 3/8
L-3	2 1/2	25	17	13	10
L-4	2 1/2	27	18	18 1/2	16 1/4
L-4	2 1/2	27	18	18 1/2	16 1/4
L-5	2 1/2	27	18	12 1/2	11 1/2

The proportions of the link determine the amount the lead increases from full to mid gear and in many cases of the older Stephenson link engines, this increase of lead amounts to from 7/16 in. to 9/16 in., which means that with the reverse lever on center, the smallest possible port

opening is 7/16 in. to 9/16 in., or whatever the increase amounts to, if set line and line in full gear. The shortest possible cut-off under these conditions is frequently 33 per cent of the stroke, which is entirely too much and is wasteful in the use of steam. It makes a sluggish engine as well, due to too great a volume of steam to get rid of through the limited exhaust port opening at short cut-off travel.

DATA USED WITH FIGURE 6

Engine, Class	Link radius B, in.	Link hanger C, in.	Saddle pin backset D, in.	Link print	Valve travel, in B. P.	Valve travel, in Limit to
G-2	60	16¼	½	2161-D	5¾	5¼
H	44¾ 40	19¾	1⅝	3009-D	6	6
I-4	45	17¼	1	1034-D	5 7/16	5⅜
I-4	45	17¼	1	1034-D	5 7/16	5⅜
I-5	45¾	....	11/16	2981-C	5 7/16	5⅜
L-2	56	18½	13/16	3009-D	6¼	6¼
L-2	56	18½	21/32	2589-C	6	6
L-3	46	18⅞	1⅜	2589-C	6½	6½
L-4	56	18½	13/16	3009-D	6¼	6¼
L-4	56	18½	13/16	3009-D	6¼	6¼
L-5	42	20½	1½	2589-C	6	6
L-5	42	20½	1½	2589-C	6	6

The manner of calculating the increase in lead and the calculation of the amount of blind to make the back up to maintain at least line and line in full forward gear is shown in the diagrams.

Investigation has developed that it is possible by means of a set of trams to take exact measurements of the length of the eccentric blades and fit up eccentric straps and blades on the floor before assembling, thereby requiring a minimum of skill and work on the part of the valve setter.

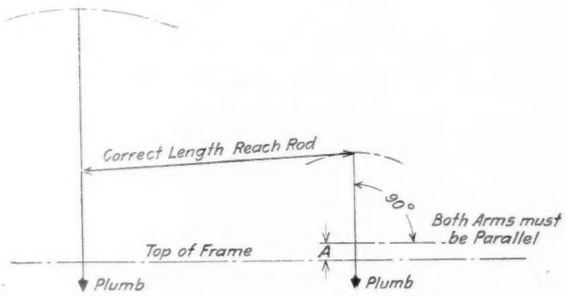
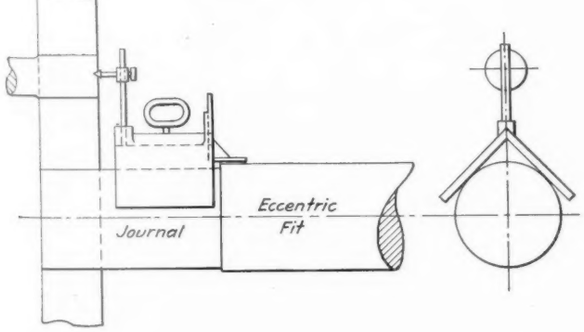


Fig. 7



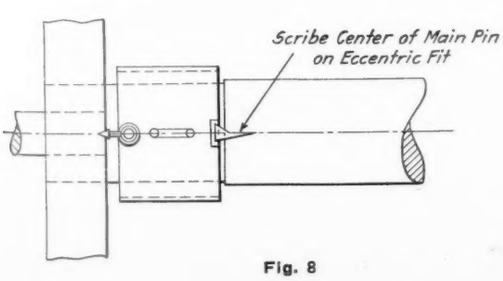


Fig. 8

Setting valves is simply making adjustments for various inaccuracies in the assembling of the locomotive. If all parts had the same relation to each other as called for in the drawings the valves would be set correctly when assembled. Therefore, the more parts that conform to the drawings before starting to set valves, the less adjustment will be necessary to produce the desired results.

First Operation—Prove the length of the valve over the edges of the steam and exhaust ports in the valve chamber by means of a standard gage.

Second Operation—Take port marks in the usual manner.

Third Operation—Prove the length of the reach rod, reverse shaft and rocker arms as in Fig. 7.

Fifth Operation—Locate the eccentrics on the axle before wheeling the engine. First, transfer the center of the main crank pin to the eccentric fit on the axle with a box gage, Fig. 8. Locate eccentric keyways with the standard gage for each class of engine. For engines having slide valves with indirect rocker, see Fig. 9. The gages are to be made in accordance with the following table:

Engine, Class	Gage No.	Lap, in.	Lead, in. F	Lead, in. B	Ecc. fit Z, in.	Distance from pin. in. F. M	Distance from pin. in. B. M.	Ecc. throw, in.
G-1	2	⅞	line and line	1/16 blind	9	5-9/32	5-15/32	2½
G-2	3	1	line and line	..	8	4⅞	4⅞	2½
I-4	4	⅞	line and line	1/16 blind	7¾	4½	4-21/32	2½
I-4	4	⅞	line and line	1/16 blind	7¾	4½	4-21/32	2½
I-5	5	⅞	line and line	1/16 blind	8¼	4-25/32	5	2½

Note—Engines not covered by above table to be set line and line.

Fourth Operation—Prove the link and hangers as in Fig. 6.

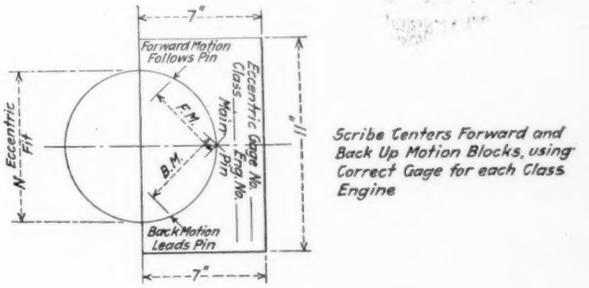


Fig. 9

For engines having piston valves (inside admission) and direct rockers, use gages similar to those described for slide

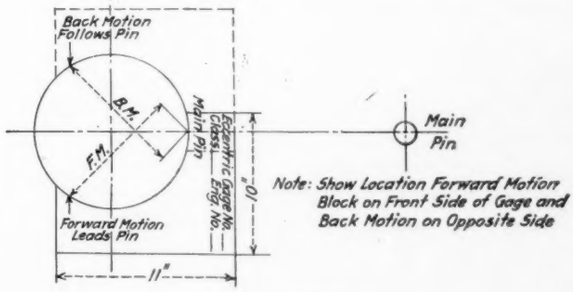


Fig. 10

valves, but made to the dimensions shown in the following table:

Engine, Class	Gage No.	Lap, in.	Lead, in F	Lead, in B	Ecc. fit Z, in.	Distance from pin, in, F. M.	Distance from pin, in, B. M	Ecc. throw, in.
L-2	1-A	1⅛	..	¼	9 3/16	5 3/16	5 3/16	2¾
L-2	1	1⅛	..	¼ blind	9 3/16	5¼	5 5/16	2¾
L-4	1	1⅛	..	¼ blind	9 3/16	5¼	5 5/16	2¾

For engines having piston valves (inside admission) and indirect rockers, see Fig. 10, the gage to be made in accordance with the following table:

Engine, Class	Gage No.	Lap, in.	Lead, in. F	Lead, in. B	Ecc. fit Z, in.	Distance from pin. in. F. M.	Distance from pin. in. B. M	Ecc. throw, in.
H	6	1⅛	1/32	1/32	9 1/32	8¼	8¼	5
L-3	7	1	1/16	1/16	8 1/32	7-7/32	7-7/32	5
L-5	8	1	1/16	1/16	9 1/16	7-23/32	7-23/32	5½
L-5	8	1	1/16	1/16	9 1/16	7-23/32	7-24/32	5½

Sixth Operation—Prove the keyways in the blocks. After locating all keyways correctly on the axle, check the keyways

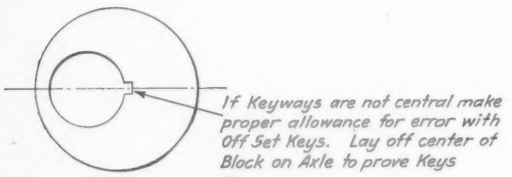


Fig. 11

in the old eccentrics to prove that they are centrally located. See Fig. 11.

Seventh Operation—Approximate length of valve rod. Plumb the rocker arm or transmission hanger and alter the valve rod until the tram is central between port marks as in Fig. 12.

After performing the above operations correctly it is possible to take direct from the engine by a set of five trams,

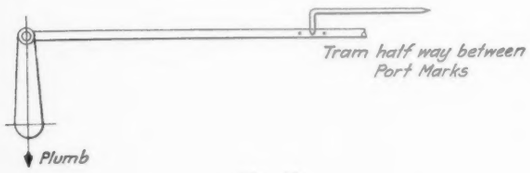


Fig. 12

the correct length of each eccentric blade. After using the proper tram to set the link correctly the following rules must be observed:

(1) Place the engine on the forward dead center for each side separately. This applies to all engines except classes H, L-3 and L-5, having inside admission piston valves, with indirect rocker, which engines are placed on the back dead center.

(2) Place the reverse lever on the center.

(3) Move the valve stem in the direction to open the valve off the central position (found by operation seven)

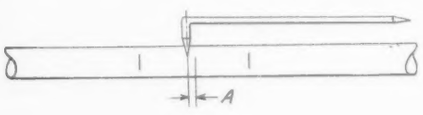


Fig. 13

an amount equal to the increase lead from corner to mid-gear, as shown in operation eight.

Eighth Operation—Move the valve stem toward the lead opening. The amount of lead increases from corner to mid-gear. See Fig. 13.

Engine, Class	A, in.	Direction of A
G-1	1/32	Toward lead
G-2	11/32	Toward lead
H	¼	Toward lead
I-4	1/16	Toward lead
I-5	3/16	Toward lead
L-2	1/16	Toward lead
L-3	1/32	Toward lead
L-4	1/16	Toward lead
L-5	1/16	Toward lead

Ninth Operation—Set the link and clamp it in position to tram the length of the blade. The lever must be on center. See Fig. 14.

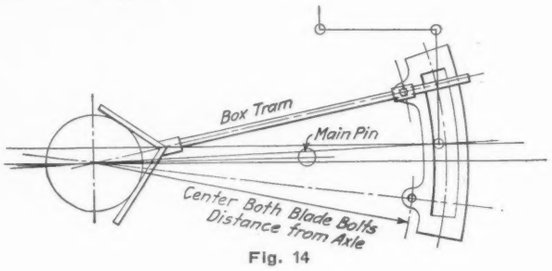


Fig. 14

Tenth Operation—Take the length of each blade separately with the engine on forward dead center for the side on which lengths are being taken. This applies to all engines

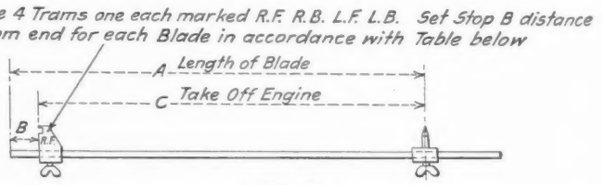

Use 4 Trams one each marked R.F. R.B. L.F. L.B. Set Stop B distance from end for each Blade in accordance with Table below
A Length of Blade
C Take Off Engine
B
R.F.

Fig. 15

except class H, L-3 and L-5, which are to be on the back dead center, as in Fig. 15.

Engine, Class	Distance B, in. Forward	Distance B, in. Back
G-1	25/32	21/32
G-2	7/8	7/8
H	1⅛	1⅛
I-4	25/32	11/16
I-5	25/32	11/16

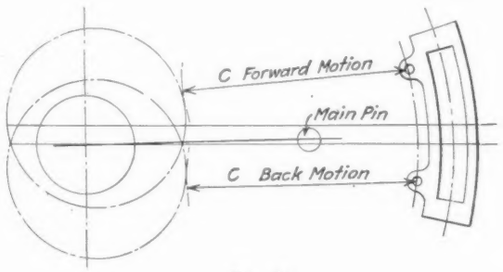


Fig. 16

L-2	1	¾
L-3	1	1
L-4	1	¾
L-5	1⅛	1⅛

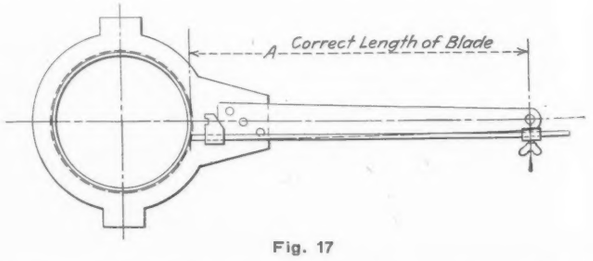


Fig. 17

Eleventh Operation—Take length distance *C* as in Fig. 16.

Twelfth Operation—Assemble the blades and straps to

correct length *A* on the floor before applying to the engine. See Fig. 17.

GAGE FOR CHECKING CYLINDER PORTS AND SLIDE VALVES, SEE FIG. 18

Engine, Class	Valve face, in. E	F	G	Cylinder ports, in A	B	C	D	Lap, Steam, in.	Clearance, Exhaust, in.
G-1.....	2-7/32	5 9/16	10	8¼	3	1¼	1⅜	⅞	1/32
G-2.....	2-11/32	5 9/16	10¼	8¼	3	1¼	1⅜	1	1/32
I-4.....	2⅛	5½	9¾	8	3	1¼	1¼	⅞	Line and line
I-5	2¼	5½	10	8¼	3	1¼	1⅜	⅞	Line and line

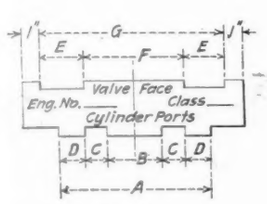


Fig. 18

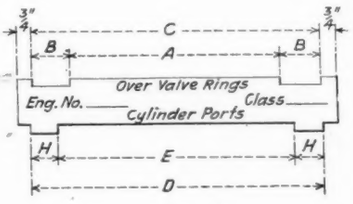
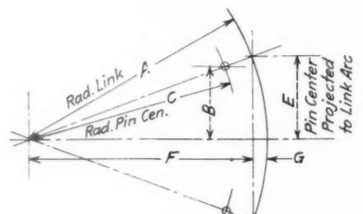


Fig. 19

GAGE FOR CHECKING CYLINDER PORTS AND PISTON VALVES—SEE FIG. 19

Engine, Class	Over valve rings, in. A	B	C	Cylinder ports, in. F	H	D	Lap, Steam, in.	Clearance, Exhaust, in.
L-2...	22½	2-21/32	27-13/16	24¾	1⅝	28	1⅛	3/32
L-3...	19	2½	24	21	1½	24	1	....
L-4...	22½	2-21/32	27-13/16	24¾	1⅝	28	1⅛	3/32
L-5...	16¾	2½	21¾	18¾	1½	27¾	1	....
H.....	22½	2-21/32	27-13/16	24¾	1⅝	28	1⅛	3/32

The amount of increase in lead from full gear to mid-gear is determined by the radius of the link and the distance between blade pins. On all locomotives having open eccentric rods the lead increases when hooked up. On all locomotives having crossed eccentric rods the lead decreases when hooked up and the engine becomes very blind in mid-gear, in some cases as much as 9/16 in. blind. This gear is very undesirable. To overcome this give 5/16 in. lead



Formula

$E = \frac{BA}{C}$

$G = A - F$

$F = \sqrt{A^2 - E^2}$

Fig. 20

in the corner and the engine will not go blind until worked at less than half stroke. See Fig. 20.

Open Rods—Lead increases from full gear to mid-gear. This combination is used on all engines having (1) inside admission piston valves and direct rocker or (2) outside admission valves and indirect rocker. See Fig. 21.

Crossed Rods—Lead decreases from full gear to mid-gear. This combination is used on all locomotives having

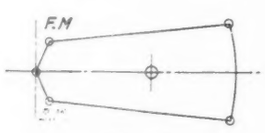


Fig. 21

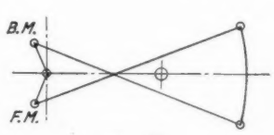


Fig. 22

inside admission piston valves and direct rocker. See Fig. 22.

By using indirect rocker with this combination of rods the lead can be changed from decrease to increase.

Valve Diagrams—After determining the amount the lead increases from full gear to mid-gear, it usually develops that if both forward and back motion blocks are set line and line the lead increases to such an amount that the port opening is so great even with the reverse lever on center that the shortest cut-off possible has been found to be nearly 30 per cent of the stroke. To overcome this defect set the back motion blind enough to reduce the lead to 5/16 in. in mid-gear, as determined by the Zeuner valve diagram.

Example: Valve travel 6¼ in., lead increase 7/16 in.

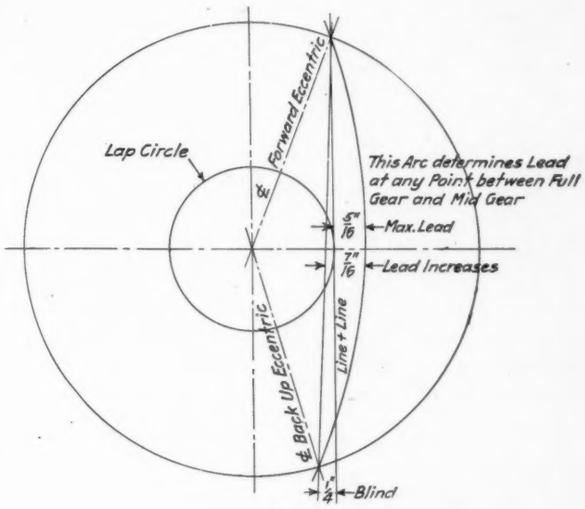


Fig. 23

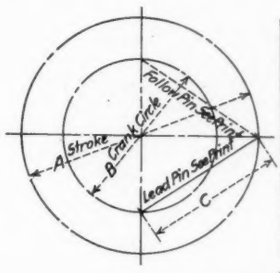
from line and line, lap 1⅛ in. To find the amount to blind, back up to produce 5/16 in. lead on center with forward motion line and line. See Fig. 23.

For some unknown reason the lead does not increase as it should by using the indirect rocker with crossed rods and it has been found necessary to set one class of Consolidation type with 5/16 in. lead in the corner to have 3/16 in. lead on the center, but this type of construction is very old and only a few such engines are still in existence.

SOUTHERN VALVE GEAR

All locomotives having Southern valve gear are designed for constant lead, and should be so set. It is not possible to set this gear for variable lead and it should never be attempted. By adopting the process of elimination, proving one part at a time, the best results are obtained.

All of the motion to the valve is imparted from the eccentric crank. Since the lap and lead depends on the



Eng. No. New	Eng. No. Old	Class	A	B	C	Crank
		K	28"	21"	17 5/8"	Lead Pin

Fig. 24

length of the eccentric rod, the correct length must be maintained. In this gear the center of the main axle is the fixed point and the link must be brought to the proper relation to the main wheel center. The best results can be obtained by following the instructions given below.

First Operation—Set eccentric crank in accordance with the drawings of the gear. See Fig. 24.

Second Operation—Prove the reach rods and links. See Fig. 25.

Third Operation—Square the lead and adjust the valve

rod. With the engine on dead centers take lead marks on the valve rod and equalize the lead by altering the valve rod. Have the lever on center when taking the lead marks.

If the above work has been properly performed the reverse lever can be placed in any position with the engine on either dead center and prove constant lead. Squaring the

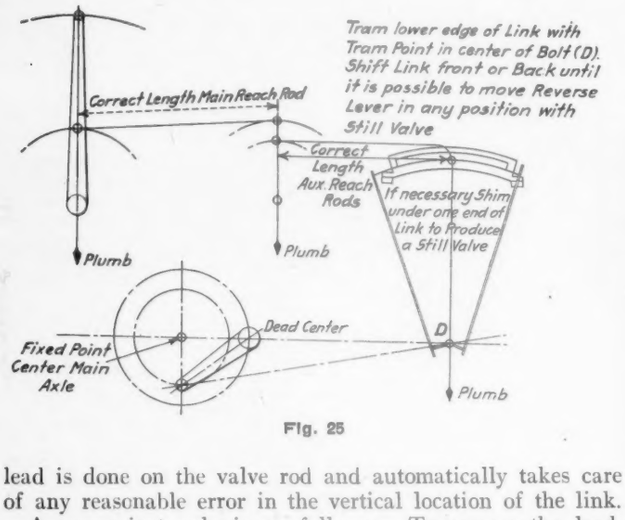

Tram lower edge of Link with Tram Point in center of Bolt (D). Shift Link front or Back until it is possible to move Reverse Lever in any position with Still Valve
Correct Length Main Reach Rod
Correct Length Aux. Reach Rods
If necessary Shim under one end of Link to Produce a Still Valve
Plumb
Plumb
Plumb
Dead Center
D
Fixed Point Center Main Axle

Fig. 25

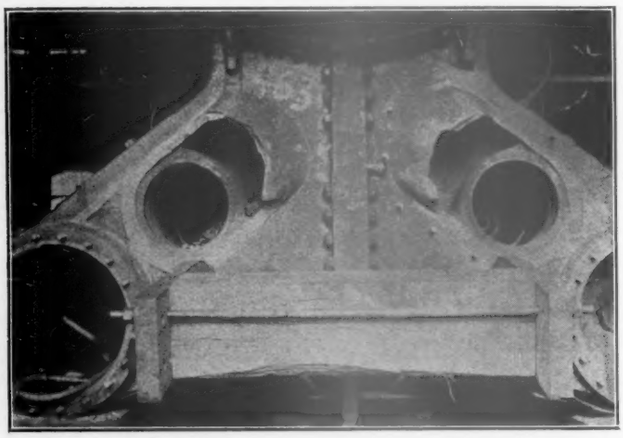
lead is done on the valve rod and automatically takes care of any reasonable error in the vertical location of the link.

A convenient rule is as follows: To square the lead, adjust the valve rod only. To equalize the cut-off adjust the link until a still valve is obtained when the engine is on either dead center and a square cut-off is the result. If over-all cut-off on one side is greater than the other, shorten the auxiliary reach rod ¼ in. for each inch of cut-off it is desired to reduce.

PATCHING PISTON VALVE CYLINDER

An interesting job of welding, performed in the repairing of a pair of piston valve cylinders, was recently done at the Stony Island shop of the New York, Chicago & St. Louis.

The broken parts of the cylinders were first drilled and chipped off flush with the main body of the casting, forming a smooth surface. Two flanged patches, as shown in



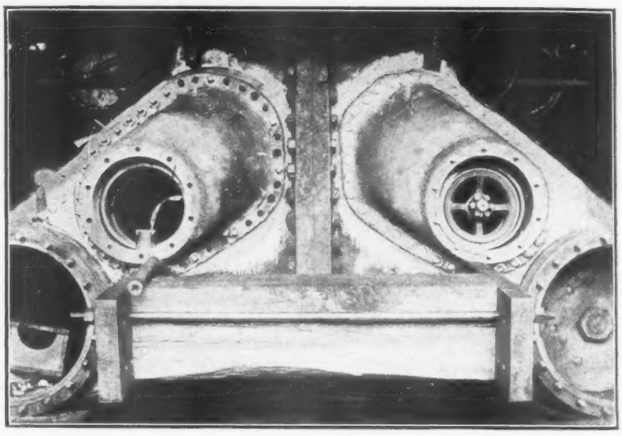
The Broken Cylinder as Received in the Shop

the sketch, were formed of ½-in. boiler plate and a ½-in. by 5-in. by 5-in. angle. The boiler plate extended to the center line of the piston valve cylinder, as shown, and the back half of the circle was formed of the ½-in. angle, the two parts of the patch being welded together with acetylene. The holes for the valve chamber were then cut out with an acetylene torch.

A ring was shaped from ¾-in. steel plate and faced and welded to the main patch, forming the valve chamber head joint and the body for the cylinder head studs.

Four holes were punched in the patch, the patch put on the cylinder, and the flange heated and set up with a flatter. After the patch was properly shaped the holes were drilled in the flanges, on 2½-in. centers, the patch again applied and reset. The patch was then taken off and put on a boring mill and the joint faced and the hole bored to admit the valve.

The patch was then reapplied to the cylinder with a



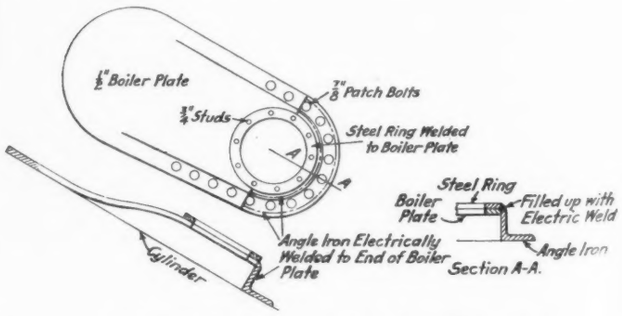
The Cylinder Casting with Patches Applied

1/16-in. copper gasket and patch bolts put in and set as the work progressed. The patch bolts being applied, the edges of the patch and the heads of the bolts were caulked and the job was complete.

The cost of the material and labor for the repairs to this cylinder were as given below:

Labor		
Erecting shop	$251.04	
Boiler shop	129.32	
Tin shop (gasket)	.68	
Total for labor		$381.04
Material		
300 lb. ½-in. by 36 in. by 96-in. steel	$10.19	
76 ⅞-in. patch bolts	8.29	
20 ¾-in. by 3-in. studs	1.20	
11 lb. ⅛-in. copper	.24	
3 ft. 5-in. by 5-in. by ½-in. angle iron	1.70	
Total for material		21.62
Total for application of the two patches		$402.66

This method of repairing proved effective and permitted



Construction of Patch for Piston Valve Cylinder

the reclamation of these cylinder castings without the necessity of removing them from the locomotive, thus considerably reducing the length of time the locomotive was out of service.

THE CASEHARDENING OF STEEL

Methods Employed; Their Effects, Proper Packing and Control of Temperature Are Important Factors

BY J. F. SPRINGER

THE casehardening of steel is quite an old process, but it is, nevertheless, one of great usefulness, both from a technical and an economic standpoint. It can not be said, however, that it is a thoroughly understood process; nor that the practitioners are everywhere succeeding uniformly in getting the best possible results. In the United States the problem does not seem to have had from our best technical men the attention it deserves nor even the attention given to certain other subjects of no greater industrial importance.

Casehardening is a process of impregnating the exterior layer of low-carbon steel with a high percentage of carbon, thereby making it possible to harden this external layer and leave the interior soft. It is an exceedingly valuable result when adequately achieved.

It is frequently of very great importance to get a thorough understanding of what is *not* wanted, as this greatly assists in getting the results actually desired. The regulation procedure in casehardening is briefly as follows: The articles to be treated are packed in boxes or cases in a packing material competent to supply carbon, such as bone dust, charred leather or the like. The box is sealed and the whole then heated to a fairly high temperature and maintained at this temperature for a considerable period. The heat causes the packing to give off carbon and the metal to absorb it. The impregnation which takes place involves first the external shell or case of the various articles. There is no great difficulty in getting this general result, nor in carrying it to the point that the impregnated shell is moderately thick and possesses a high local percentage of carbon. It is, however, difficult to avoid one or more of the following results, undesirable in the best work:

(1) The zone or shell of high carbon percentage may be very sharply defined from the soft interior. Upon giving the hardening treatment, a shell of very hard steel inclosing a core of soft metal is the result. There is a sudden change from the very hard to the soft. The effects of concentrated shocks on the exterior are accordingly localized upon the soft interior. This means that the interior is unable to present the resistance of which it is really capable, because of the lack of distribution of the shock. The exterior shell being thin and brittle is, accordingly, liable to break.

(2) The highly carbonized shell may vary in thickness. This is undesirable because it means regions of unequal resistance to externally applied wearing pressures. If a shell of 1/32 in. thickness is sought as the thing really desired, then spots only 1/64 in. thick will not be desirable.

(3) The external shell when heated and quenched may prove insufficiently hard. This is a serious matter. Hardness is wanted frequently, not to say generally, for the purpose of resisting the abrasive action of wear and tear. As this resistance is fairly proportional to the degree of hardness, a falling off in hardness is not wanted.

(4) The depth of the hardening effect may be insufficient. This means that the shell of high impregnation is not thick enough. The external hardness desired may be fully attained; but the life of the article in actual service may be greatly shortened because the resistance to wear is gone long before the depth of wear really permissible in the part is reached.

(5) The hardness developed may be found to vary in different regions. This will often be a highly objectionable result. In a machine, it is not desirable that a part should wear unevenly as uneven wear generally means distortion.

(6) Finally, the interior may have lost in physical qualities. Such loss is due to the overheating necessarily a part of the casehardening procedure. This is a very serious matter, probably appreciated by a comparative few. It is, nevertheless, a fact that steel heated above a medium cherry red (1,274 deg. F.) is subject to enlargement of its crystals. This enlargement increases as the temperature is carried further. It is pretty well established that enlarged grains mean reduced physical strength—particularly tensile strength—and that this reduction varies with the overheating beyond medium cherry red. The casehardening temperatures are all above this level, so that the interior of any casehardened article is probably more or less damaged in quality when it comes from the furnace.

In general, what is desired is casehardened articles not subject to any one of these defects. I call attention to one or two of these by way of emphasis. The same degree of hardness over the whole region is manifestly dependent upon the evenness of carburization. Anything in the technique on the materials that will tend to produce regional differences of impregnation are the things to discover and provide against. This should not be confused with variation in depth of penetration. Again, the gradual shading off in the degree of carburization is highly important. It is probably the only thing that will serve to distribute the effects of concentration of shocks from the outside. Finally, the need to restore, as far as possible, the damaged steel of the interior is perhaps the least appreciated.

THE BOXES

The boxes or cases used to hold the work and the packing material during carburization and to retain the carbon and thus force impregnation can not be made from any and all materials, if economy in the cost of such boxes is to be kept in view. Two materials are generally approved—cast steel and sheet steel. Usually, the cast steel box will outlive the one of sheet steel, the conditions being the same. A rough estimate would give the cast box a life from 25 to 30 per cent longer. "Life" is not to be understood as measured by the total elapsed time, but by the number of operations. Under very good conditions the cast steel box may be used anywhere from 15 to 20 times, but the life of the box depends on a number of things—the temperature of carburization, the period of high heat, the strength of the oxidizing atmosphere in the furnace, the mechanical treatment, etc. A furnace having a reducing atmosphere—such as these burning heavy oil—will serve to prolong the life of the boxes. The first cost of the cast steel box will probably be greater, and this will be more or less of an offset to the longer life. The weight of this box will also be greater, which is a disadvantage.

If cast steel is employed, the box should be cast of soft steel. The lid may be of the same material or it may be of sheet metal. For a cast steel box 12 in. by 14 in. by 24 in. in size, wall thickness of 4/5 in. or 1 in. will be proper. If sheet steel is selected, the carbon percentage should be low. The wall thickness for a box of the foregoing dimensions may properly be 2/5-in. or 3/5-in. The seams may be gas or electrically welded.

The size of the box is important. In general, for miscellaneous work the size already given may be considered suitable. Dimensions much exceeding those given should be con-

sidered well before they are adopted. The cubic contents should be limited to two cubic feet, or in exceptional cases to three cubic feet, as large boxes generally mean that the heat penetration will be slow. The following objections to such boxes have been expressed: (1) Considerable deformation of the pieces constituting the work, this deformation arising from the inequality of temperature at different points in the box; (2) considerable irregularity in the impregnation, due to the same cause, and (3) the excessive time period necessary to get results. When very large pieces are to be treated the fixed heating compartment may be used. Quite small boxes are desirable, if the work permits. Thus, a box 12 in. by 10 in. by 10. in. is a good one for small, miscellaneous work. Homogeneous impregnation is promoted by the cylindrical box, but this type does not lend itself so readily to handling. This point needs to be considered, as much of the handling is done while the workman is exposed to the heat.

The inside dimensions of a box should be such that the work may be placed in it in such a position that there is no less distance than 1¼ in. or 1½ in. between the work and box at any point.

The cover may, for the box made of either approved material, be of cast iron, cast steel or sheet steel. In all cases, however, the joint is to be such that a good closure may be effected. The cover may fit over the sides of the box.

CHARGING THE BOXES

The bottom of the box is coated with a paste made from clay and water. This should be done some considerable time before the work is to be put in, as it is necessary to wait for the paste to dry thoroughly before taking the next step. The packing material is then put in until a layer, when compressed, is 1½ in. thick. The condition of the packing material is of importance. It should be very dry and well pulverized. If the work consists of rather small pieces, a layer, one article thick, may be arranged. The intervals between articles is nowhere to be less than 1 or 1¼ in. A similar rule applies to the intervals between the walls of the box and the sides of the work, whether the work be large or small. The large single article or the layer of small articles is now packed tightly with the packing material, until the latter is at the highest level of the work. Then a layer of packing not less than 1½ in. thick is packed in tight.

The object in allowing generous intervals between metal surfaces is to guard against actual contact and to provide an adequate amount of material to supply the required carbon. If the final layer of packing will not, when 1½ in. thick, completely fill the box, enough is to be put in to do so. The cover is now put on and the joint sealed everywhere with a paste or mortar made by mixing fire-clay and water.

The whole is now ready for the furnace, except for the possible presence inside of moisture and for the wetness of the seal. However, the box may be put into the heating compartment and left near the door or in some other comparatively cool spot until one is satisfied that all water, especially inside, has escaped.

THE PACKING MATERIAL

The character and condition of the packing material are exceedingly important, not to say vital. There has probably been a good deal of nonsense promulgated in extolling the virtues of complicated preparations. Nevertheless, a good deal of success no doubt has attended the use of some mixtures of this character. But why use complicated mixtures when comparatively simple ones will give equal results? Of course, we should all elect to be "from Missouri" and stand willing to be convinced by actual test.

The packing must contain carbon in some form, otherwise there will result no impregnation with carbon. Various varieties of wood charcoal, such as oak and beech charcoals, are suitable for packing. Charcoal made from leather, or horn, soot, barium carbonate, coke, etc., have all been used as sources of carbon.

But the packing should have certain physical properties as well as possess a carbon content. There should, for example, be more or less porosity to permit the gases to get through. Then there should exist a capability to maintain its volume despite the heat and the escape of gases from its substance. Otherwise, the work might settle unevenly and so suffer deformation. Again, it should be a fair conductor of heat. If not, then there may be great differences of temperature in the interior of the box, the center being much cooler than points near the surfaces of the box. It is also considered advantageous if the packing consolidates well and is at no time of a dusty character. Both these qualities may at times be imparted to packing which lack them but are otherwise suitable. Thick oil may be mixed with the material. The specifications as to heat conductivity and porosity are more or less incompatible, so that a compromise may often be necessary.

Uniformity of action is something to be prized. Simple mixtures are probably the best from this point of view, especially if they tend to retain the gases which they produce until a red heat has been attained—that is, a temperature of some 1,200 deg. F. Vegetable or animal charcoal alone meets this requirement very well. However, wood and bone charcoals do not act to the best advantage through the earlier part of the carburizing range. They may be stimulated to activity by the addition of an alkaline carbonate. Barium carbonate and sodium carbonate—both low-priced chemicals—are advantageous additions to wood charcoal. As between beech and oak charcoals on one hand, and charcoals from other woods, the former are probably better than the latter; but the mode of making the charcoal is of greater importance than the precise kind of wood.

The use of barium carbonate with wood charcoal tends to produce a coloring effect upon the work. That is, the work is apt to come out covered with a thin layer or deposit of graphite. This tendency, if objected to, may be corrected by the addition of 10 per cent of saw dust to the mixture, W. H. Dyson being authority for this statement. It is thought that the deposit is due to the contact with the work of carbon monoxide (CO) which has been liberated at temperatures below 1,475 deg. F. In actual practice, however, the undesirable temperatures ought to be passed in a short time. The deposit ought then to be rather a thin one, if it is present at all. If trouble is experienced, the saw dust remedy may, of course, be readily applied.

Granulated bone is the usual material employed in the United States. It gives satisfactory results in many cases, but it seems to possess an objectionable characteristic when used for a prolonged period at a high temperature. As the extended period and the elevated temperature may be needed to get certain results, it will be of advantage to consider this matter further. If bone is ignited and burnt, the ash, amounting perhaps to anything from 50 to 80 per cent of the weight of the original charcoal, will be found to consist principally of calcium phosphate. In a carburizing box, under the influence of the heated metal and charcoal, a reduction of calcium phosphate may take place. This would mean the liberation of phosphorus, which may then combine with the iron of the soft steel, and phosphide of iron would be the result. This substance is brittle and melts at a low point. Forming on the surface of a casehardened object, it will at times produce a roughening of that surface, or a blister may be formed. In an actual case, splinters were secured and tested. Phosphorus to the amount of 2½ per cent was found to be present. There was also reason to think that the carburizing temperature had reached 1,800 deg. F., or some higher level.

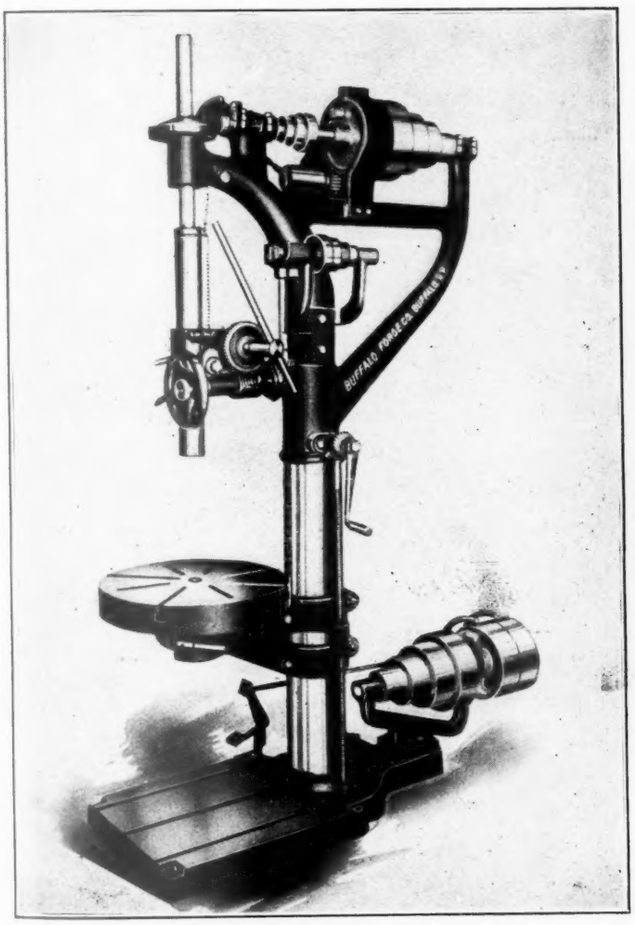
(*To be continued.*)

NEW DEVICES

A BACK GEARED UPRIGHT POWER DRILL

The Buffalo Forge Company, Buffalo, N. Y., is making a 25-in. back geared upright power drill as shown in the illustration. This machine has a 21-in. diameter table and a spindle travel of 14½ in. It has eight speeds, four power feeds and a hand lever feed. The handle is adjustable from 6 to 18 in. and is held in place by a tension spring. The worm feed wheel runs in oil and is latch-hinged to take up wear.

The mechanism can be thrown from plain to back geared drive without using a wrench. This is done by disengaging a knurled knob in the top gear and throwing in the back gears by means of the hand lever, and it is held in place by a locking screw.



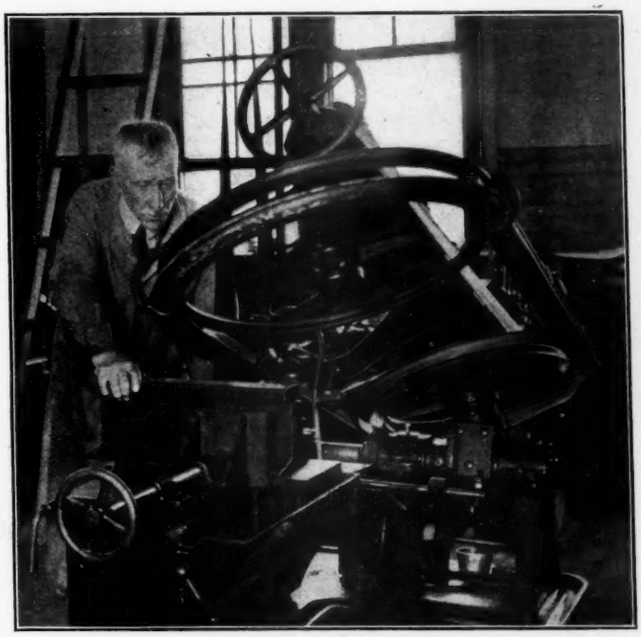
The Buffalo Upright Power Drill

Adjustable split bearings are provided for all shafts and ball thrust bearings are used where necessary. This machine is designed for accurate work and an automatic trip throws out the power feed instantly when the piece has been drilled to the required depth.

GRAVITY FEED BAND SAW

The idea of a continuous stroke hack saw has been embodied in the band saw machine, developed by the Napier Saw Works, Inc., Springfield, Mass.

The saw blade feeds into the work by gravity, due to the balanced weight of the tilting head. A spring at the back of the machine is in such a position and of such tension that the feeding weight is constant from start to finish of any cut which can be made on the machine. The gravity feed feature of this machine is a rather distinct departure from any other type of feed used for this work. When in operation the gravity feed does not force the saw band into the metal beyond the band's capacity to withstand the strain. When tough and hard metal is being cut, the feed is just heavy enough so that the teeth of the band take hold and this feed is constant as long as the uniformity of the steel remains constant. Should a softer metal be cut, the feed is heavier and better time is made.



Napier Band Saw Cutting Heavy Rail Section

The base of the machine is of cabinet type with lubricating tank enclosed. All bearings are large and those in clutch pulley and in the driving and idle wheels, which carry the tension of the saw, are extra heavy and rigid to withstand the strain.

The cutting band is lower than the returning band, as shown in the illustration, thus making it possible to cut off any length required. The cutting band is supported

by truss arms, each carrying a pair of specially designed guides.

By means of the rolling guides the band saw is directed so that its vertical travel between the truss arms is in perfect alignment, thus assuring a straight cut. These guides once set are in perfect adjustment for any saw that may be placed in the machine.

A rotary pump of simple design provides ample cutting compound for the saw. The teeth of the band saw are downward in the cut, which insures that the cutting compound flows at once to the point of the saw tooth where it is needed. The capacity of the machine is greatly increased by this ample flow of cutting compound.

An important advantage of this type of machine is the saving in metal due to taking a narrow cut. For most kinds of work the band saw blade thickness is less than .049 in. while a circular saw would be 3/16 in. thick or more. In other words, when cutting up expensive material, an appreciable saving results from the use of a band saw with a thin blade.

The following is a table of specifications and of speeds recommended:

Floor space	4 ft. by 6 ft.
Height, floor to table	26¾ in.
Length, band saw	12 ft. 3 in.
Size of band saw	1 in. by .035
Net weight	1,700 lb.

Speeds

Soft steel, 120 lin. ft. per min. of band saw; 80 rev. of driving pulley.
Tool steel, 100 lin. ft. per min. of band saw; 70 rev. of driving pulley.
Soft metals, 150 lin. ft. per min. of band saw; 100 rev. of driving pulley

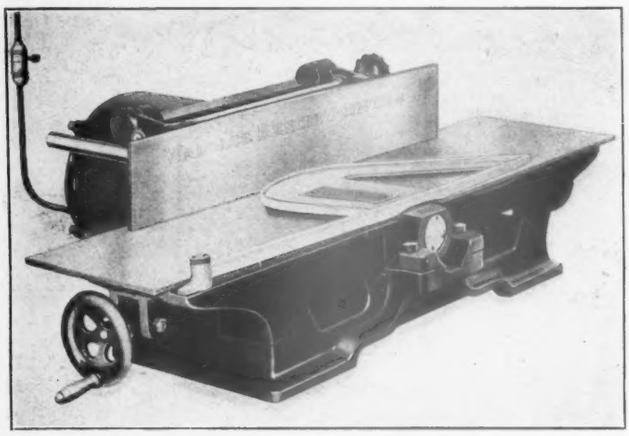
Power required	1 hp.
Geared	4 to 1
Driving pulley	12 in. by 3 in.

THE WALLACE BENCH JOINTER

A portable six-inch, motor-driven bench type of jointer has been developed and is being marketed by J. D. Wallace & Co., Chicago.

This machine was designed to place in the shop at points convenient to the workmen, thus eliminating the loss of time due to walking to and from the stationary machines. It can easily be carried by one man and thus practically becomes part of an individual tool kit.

An especially interesting feature is a new fence that has



Side View of the Jointer Showing Adjustable Front and Rear Tables and Safety Guards

been developed in connection with this machine. This fence is mounted on the motor and slides backward or forward on rods, rendering it more quickly and accurately adjustable than any ordinary machine. The fence is designed so that only a fraction of an inch is lost on the table when the fence is set for beveling.

The cutter head can easily be taken out and other heads inserted in a few seconds. The tables are arranged to slide backward to permit the use of these special heads, or forward so as to work with the narrowest possible throat opening, a feature that will prove especially desirable when the machine is doing small or very close work.

Ball bearings are used on all motor and cutter head bearings, thus eliminating friction and prolonging the life of the machine.

An ingenious and apparently very efficient arrangement of the flap and shutter guard has been effected by mounting the shutter guard on the cutter head bearing rather than in grooves.

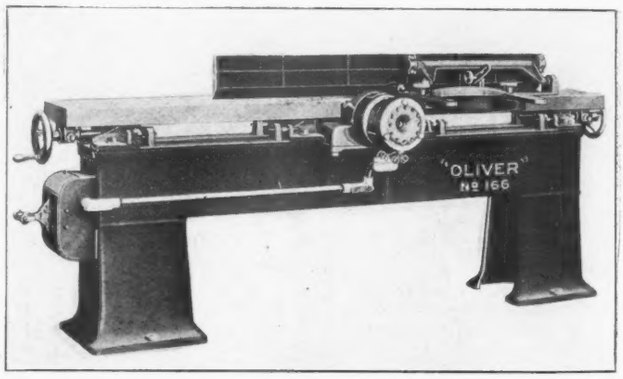
Each machine is equipped with a motor, lamp cord and plug for connection to the ordinary lighting circuit.

OLIVER HAND PLANER AND JOINTER

The Oliver Machinery Company, Grand Rapids, Mich., have placed on the market a new motor-driven hand planer and jointer.

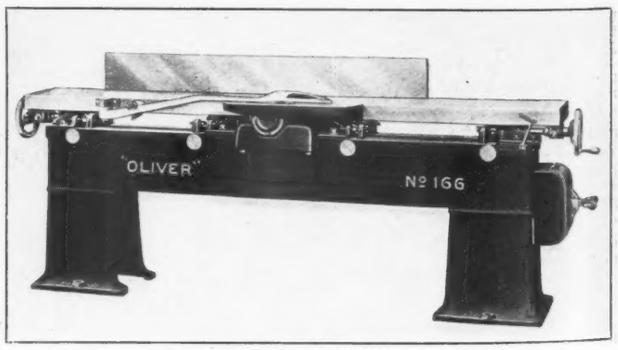
As shown in the illustrations, this machine is provided with a self-contained direct mounted motor drive. A 3,600-r.p.m., three-phase, 60-cycle, 220-volt A. C. motor and a three-knife cylinder are used.

On the outer end of the cylinders, where the pulley usually



Rear View of the Hand Planer and Jointer Showing how the Motor is Mounted

is mounted, the cylinder is shaped to receive the rotor of the motor. On the outside of this rotor and concentric with it is the stator of the motor, held by means of the adapter and the outer end cover. The direct mounted motor drive



Front View of the Hand Planer and Jointer

runs in extra large ball bearings which insures long life to the bearing and smooth operation of the motor.

This hand planer and jointer is adapted to a wide range of work and the drive is suitable where three-phase, 60-cycle, 220-volt electric current is available.

A CONVERTIBLE STOCK CAR

A DEVICE DESIGNED to convert the ordinary live stock car into a box car for general merchandise purposes has been placed on the market by the U. S. Convertible Car Company of Fort Worth, Texas.

This equipment consists of moveable floors of 2-in. pine and steel folding side walls, which are hinged to the moveable floor and to the inside of the car near the roof. As shown in the illustrations the moveable sides and floor are operated by means of ratchet cranks attached to a worm and sector device located under the car and connected to the moveable floor at each corner by a ⅜-in. steel cable moving over sheaves located inside of the car.

An old stock car to which this device has been applied is shown in Fig. 1. The water-tight live stock door 1, with the protector or water seal 4, is part of the necessary equipment, although not an integral part of the convertible device. The worm and sector 3, the ratchet cranks 5 and 6, and the side lock bolts are located as shown. This car operated successfully for a period of more than a year.

In Fig. 2 the car is shown with one end having the convertible device raised to the top of the car as when live stock is carried, and the other end with the device in place as when the car is used for general merchandise or grain.

The manner in which the device operates is clearly shown in Fig. 3, which shows the folding side walls 6 and 7 as they automatically unfold, as the moveable floor 8 is lowered into position on top of the permanent live stock floor 10. In the foreground of Fig. 3 the merchandise, or moveable, floor 8 is lowered down on top of the live stock floor 10 by operating the ratchet crank. The cable 4 running over the sheave 5 lowers the floor and the side walls unfold, the slot hinge 1 and 2, secured by the U-bolt 3, permitting the movement without any binding. The side walls are then secured against the slatted sides 11 of the car by the side lock bolts which are secured in place by the lock bolt button 13.

The general appearance of the interior of the car when arranged for merchandise is shown in Fig. 4. This shows the clean merchandise floor 2 in place on top of the live stock floor and the ventilated door 3 closed for merchandise load-

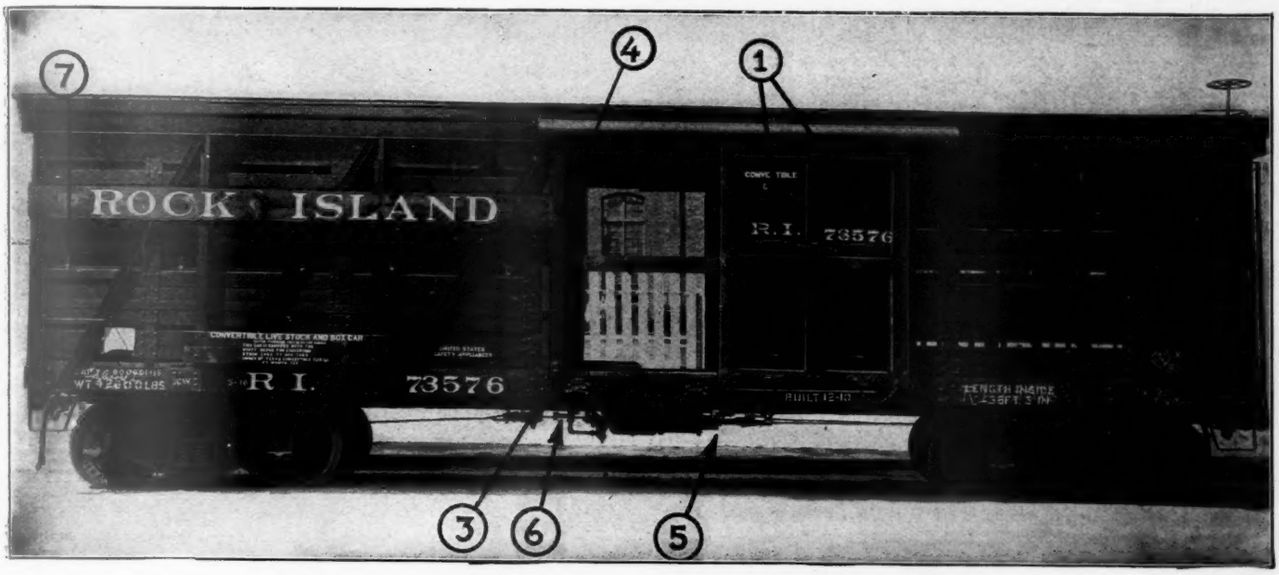


Fig. 1—A Rock Island Stock Car Equipped With the Convertible Device.

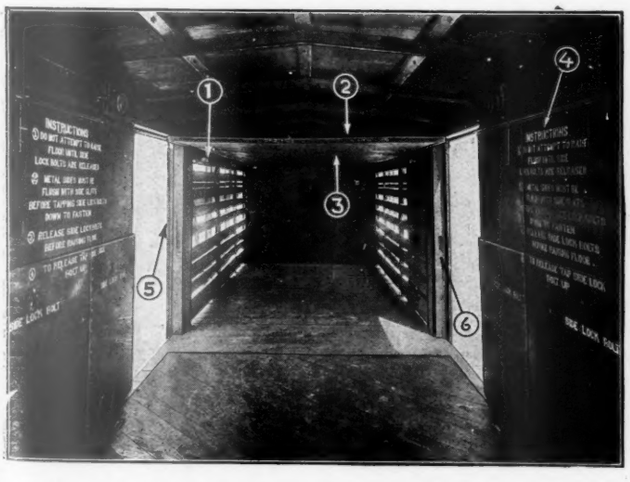


Fig. 2—One End of Car Arranged for Merchandise. (1) Safety Lock; (2) Movable Floor; (3) Showing Absence of Any Nails or projections to Injure Live Stock; (4) Instructions for Operating Device; (5) Door water Seal; (6) Provision for Fastening Grain Doors.

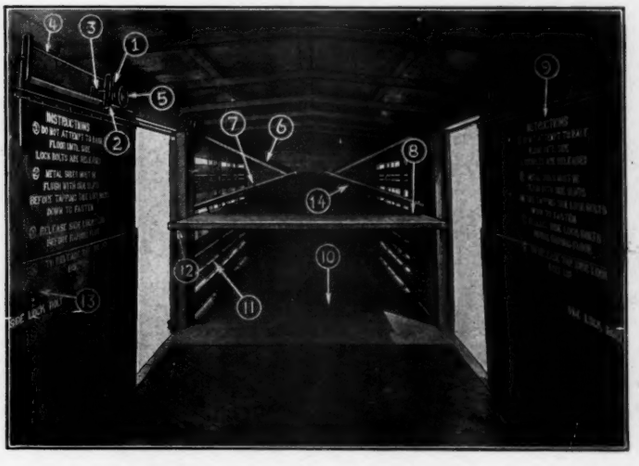


Fig. 3—One End of Car Ready for Merchandise and Convertible Device Lowering Into Position in the Other End.

ing. An end door 1 is provided so that live stock can be given necessary attention. The ends of the steel folding side walls are crimped so that the door jamb 4 is exposed to permit the application of a grain door. With the addition of a grain door this arrangement can also be used for the transportation of grain.

There are a number of advantages to be gained by the use of this device. The transportation of live stock necessitates a type of car for which it has been impossible to find freight, of a kind that can be handled in them, in sufficient quantities to load in the cars on their return trip to the stock raising sections of the country. This results in an immense

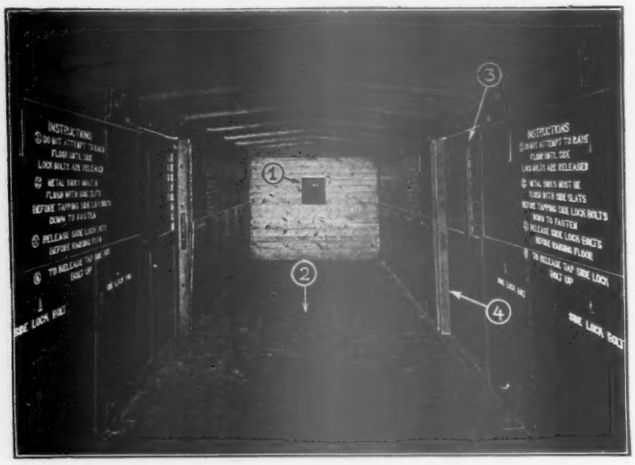


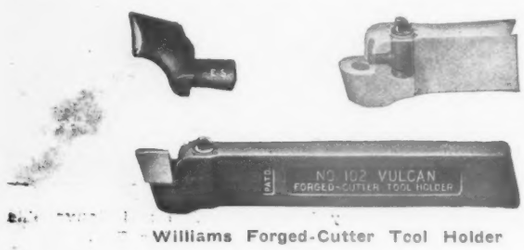
Fig. 4—Interior of Car as Arranged for General Merchandise.

loss due to non-revenue or empty car-miles. As there are long periods when there is no live stock business these cars must frequently lie idle, and it is estimated that the average time in service of such cars is only from 25 to 40 per cent.

This convertible appliance makes it possible to keep stock cars in practically continuous service, and the operation of the device is so simple that a station agent or any other person can convert from one type of car to another without any assistance from the mechanical department.

FORGED-CUTTER TOOL HOLDER

A new line of tool holders known as the Vulcan Forged-Cutter tool holders has been placed on the market by J. H. Williams & Co., Brooklyn, N. Y. As the name implies, these holders are drop forged of special steel and with their inserted cutters are adapted to the heaviest service in any regular machining operation on the lathe, planer or shaper.



Williams Forged-Cutter Tool Holder

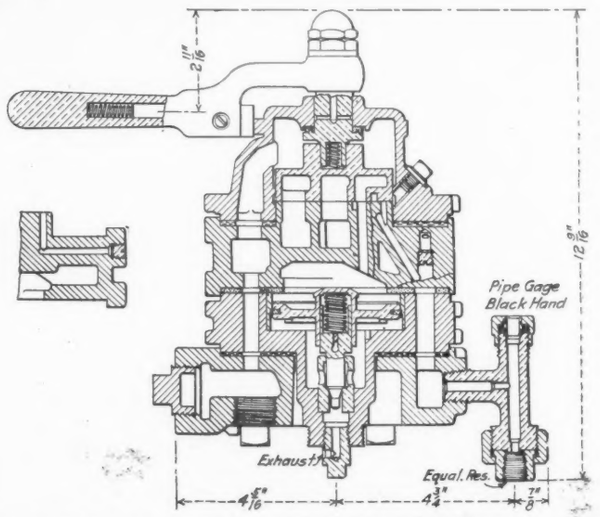
The main advantages of this type of tool are its low cost due to the small amount of high speed steel used, and the fact that by maintaining an ample stock of cutters for all regular needs, the machine operator can give his entire attention to the turning out of work and is insured against interruption due to dull or broken tools.

Referring to the illustration, the construction of the Vulcan tool holder is shown in phantom. The angular seat on the rear of the shoulder in the small figure permits the locking pin to force the heel or step of the shoulder directly against the holder proper. This method of locking provides the necessary bearing to support the cutter pressure and prevents all rocking movement of the cutter itself.

The holders are all drop-forged from a special steel, so treated as to develop its maximum toughness and stiffness. The cutters, extra heavy in design, are drop-forged from high speed steel and are finished and hardened ready for use. They are furnished in a variety of sizes and shapes, such as side, diamond point, roughing, hog nose, flat nose or threading.

COLLAPSIBLE EQUALIZING PISTON FOR H-6 AUTOMATIC BRAKE VALVE

A collapsible equalizing piston incorporated in the H-6 automatic brake valve is an innovation recently introduced by the Westinghouse Air Brake Company, Wilmerding, Pa. The device has proved of material benefit in overcoming a prevalent undesirable condition in passenger service of overcharging the equalizing reservoir. This condition is brought about on account of the increased length of trains, brake pipe volume, main reservoir pressures and high differentials of pressures, which require a close fitting piston. The collapsible feature insures equality of brake pipe and equalizing reservoir pressure without which brake manipulation is interfered with more or less when making the second application of a two application stop. The collapsible equalizing piston accomplishes its purpose more completely than does the solid equalizing piston as with this feature it is possible at any time during the release of the brake to move the brake valve handle to application position and secure an immediate response of the brakes.



Cross Section of H-6 Brake Valve with Collapsible Equalizing Piston

In construction the collapsible type of equalizing piston, as shown in the illustration, consists of the piston and its stem held in normal relative position by a spring in the hollow sleeve in which the equalizing discharge valve proper slides. Whenever the equalizing reservoir pressure is raised slightly higher than brake pipe pressure, as usually occurs when releasing a train of any length owing to the small volume of the equalizing reservoir, as compared with the brake pipe and auxiliary and supplementary reservoirs, the excess pressure on the top of the equalizing piston compresses the spring and forces the equalizing piston down to a position in which the by-pass grooves in its bushing are

uncovered, thereby permitting the pressure in the equalizing reservoir and brake pipe to equalize.

The collapsible equalizing piston is furnished as a part of the H-6 brake valve when so ordered, or can be supplied as a separate or repair part for brake valves already equipped with a solid piston. The only modification required in the brake valve, when substituting the collapsible piston for the solid piston, consists in cutting four by-pass grooves .044 in. deep by .088 in. wide by ½ in. long in the bottom of the equalizing piston bushing and equally spaced around the bushing.

DETACHABLE AIR DRILL

In the new air drill recently placed on the market by the Duntley-Dayton Company, Chicago, there is a unique departure from standard air drill construction. The motor

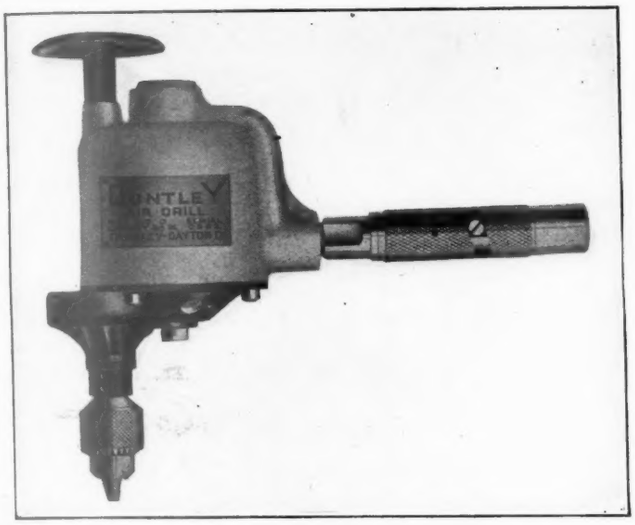


Fig. 1—Duntley Air Drill

or power unit is quickly detachable, thus making it possible by the removal of three screws and a nut, to replace or repair the motor should this become necessary. Two of the screws

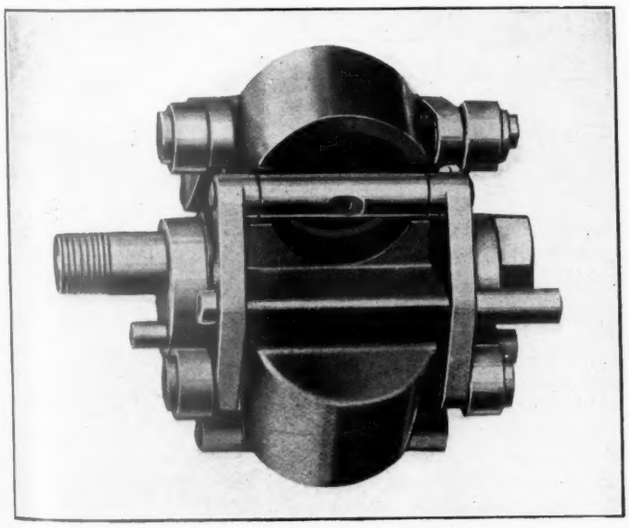


Fig. 2—Self Contained Air Motor

and the nut are shown in Fig. 1 which is a general view of the drill.

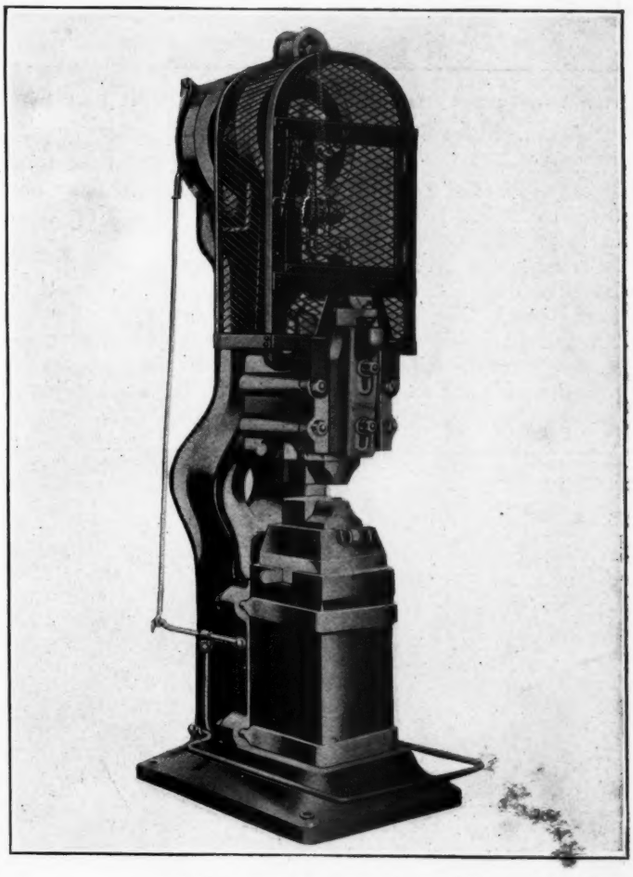
Up to the present time two sizes of breast drill have been manufactured with capacities up to ¼ in. and ⅜ in. These drills are especially adapted for drilling tell-tale holes in staybolts, and work of that character. As the motor is self-contained and well balanced, there is practically no vibration, a desirable feature in the performance of accurate work. The drill weighs only 4-½ lb.

The self-contained motor shown in Fig. 2 consists of three cylinders and pistons mounted in a frame, the entire engine rotating about a fixed crankshaft or spindle. The cylinders oscillate from a fixed base and cams on the spindle operate the valves. All working parts run in a bath of oil.

It is claimed that the Duntley air drill due to economical air consumption and lack of vibration can be used to good advantage on work hitherto performed almost exclusively by electric drills.

FAIRBANKS POWER HAMMER GUARD

To provide full protection to operators of this machine, the United Hammer Company, Boston, Mass., has designed a guard for its Fairbanks power hammer, which completely covers the working parts of the machine. The guard is made



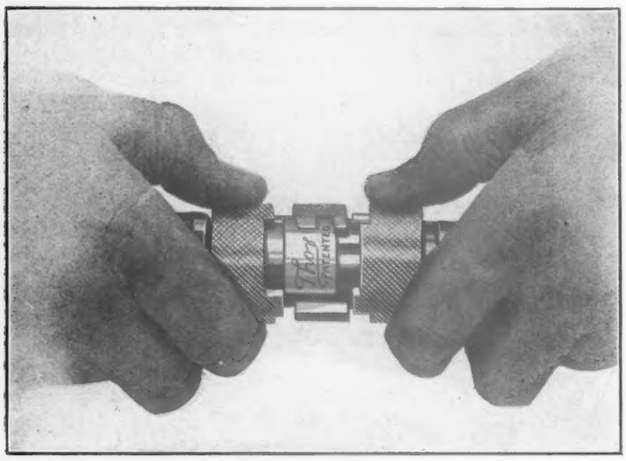
Safety Guard for Power Hammer

of woven wire stretched across a metallic frame work which fits the upper part of the machine.

By means of a door shown in the illustration, the parts are easily accessible as before, for the purpose of oiling and adjusting. The safety guard interferes in no way with the operator and is easily attached to Fairbanks hammers already in operation. It may also be applied to the new 400-lb. and 500-lb. hammers recently developed for locomotive and other heavy classes of work.

A QUICK OPERATING HOSE COUPLING

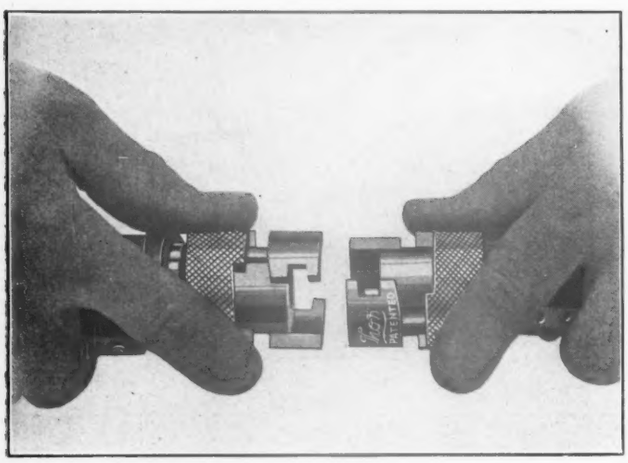
A new hose coupling with several important advantages has been placed on the market by the Independent Pneumatic Tool Company, Chicago, and is known as the New Thor Perfect Hose coupling. Its particular advantage lies in the fact that it may be disconnected instantly by a straight pull on the knurled sliding sleeves. These sleeves are plainly shown in the illustration and when they are pulled



New Thor Perfect Hose Coupling with Sleeves Pulled Back Ready to Disconnect

back the coupling ends may be disconnected without unscrewing or even twisting, as is necessary with many hose couplings. The jaws separate as soon as the locking shoulder moves back.

The beveled jaws and locking shoulders are heavy with large bearing surfaces and cannot easily bend, break, or work loose. The operating spring is large and durable, but can be easily replaced if necessary by removing the washer. An L-shaped gasket is held in place by the air pressure when the coupling is connected. It cannot be blown out when the coupling is disconnected, because of the beveled



Hose Coupling Disconnected

face on the gasket and protecting shoulder in the coupling. Gaskets are interchangeable in ⅜-in., ½-in. and ¾-in. sizes and those in the 1-in. and 1¼-in. sizes are interchangeable. The New Thor Perfect hose couplings are interchangeable between the various sizes and combinations up to ¾-in. inclusive. Each hose end is identical with the other, making a universal coupling which requires no reducers.

THE SILVER RADIAL DRILL

A radial drilling machine of well balanced design and embodying several new features, has been placed on the market recently by the Silver Manufacturing Company, Salem, Ohio. The base of this machine is strongly ribbed both lengthwise and crosswise, and the T-slots are accurately planed, ample allowance of metal being left to prevent springing. The column is of semi-steel, ground to size, the inner column or post being reinforced by heavy ribs running nearly the entire length. The outer column telescopes the post and rests on a ball thrust bearing, making the swinging of the arm extremely easy and also taking the thrust load. The arm, which is of pipe section design, has a wide bearing on the column and is heavily ribbed to resist torsional and bending strains. It is raised and lowered by power and is provided with an automatic "knock out" at both limits of travel.

The arm is firmly clamped to the column by two conveniently located levers, the bolts of which serve a three-fold purpose. As shown in Fig. 1, these bolts act as limit screws to prevent sagging and also as binders. In addition to this, when the levers are placed in the clamping position they

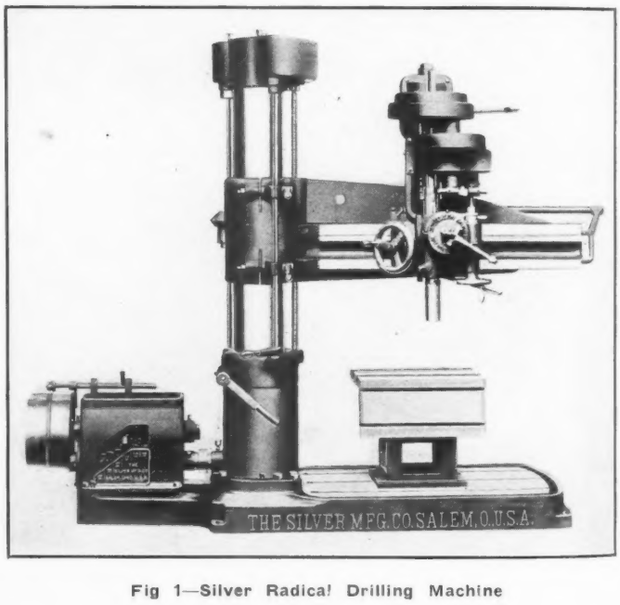


Fig 1—Silver Radical Drilling Machine

tighten the split hub through which the elevating controller shaft runs, which prevents the elevating screw from being set in motion while the arm is clamped to the column. This avoids any danger of wrecking the machine.

Another feature is the safety nut shown in Fig. 2. The purpose of this nut is to prevent the arm from dropping when the threads become worn in the elevating nut. The safety nut runs idle with ⅛-in. clearance between it and the arm, and when the threads wear out in the elevating nut, the load is transferred to the safety nut, which brings it flush with the arm, thus warning the operator in ample time to make replacement and avoid serious accident. The safety nut also provides for continuous use of the machine while the elevating nut is being replaced.

The head is arranged for rapid travel along the arm and contains a two-speed back gearing that may be shifted while running. The spindle is accurately ground to size and double splined. The rack is cut directly on the sleeve, insuring a wide bearing for the hardened rack pinion. Eight feed changes are provided, any one of which may be obtained while drilling by two conveniently located T-handles, which are plainly indexed. Other advantages are a depth gage,

automatic feed trip and tapping attachment. Six speed changes are available, which, with back gears on the head, provide 12 speeds in all. All gears in the speed box run in an oil bath.

The silver radial drill is manufactured in three sizes—2½-ft., 3-ft. and 3½-ft.—and it drills to the center of 5-ft.

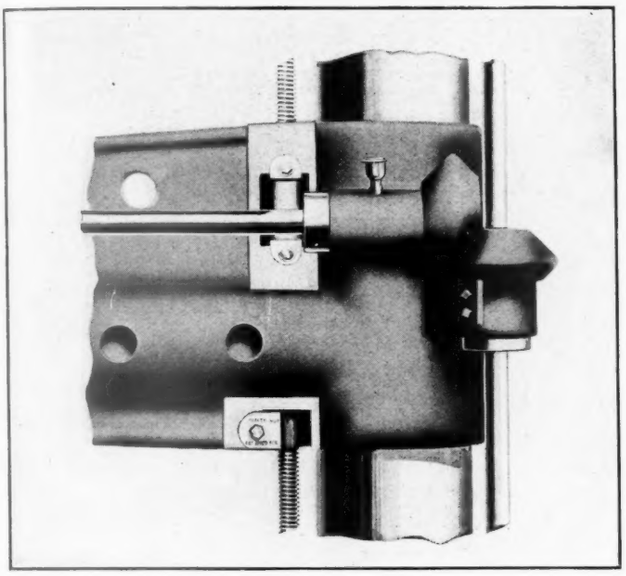


Fig. 2—Safety Nut Applied to Radial Arm

6-in., 6-ft. 6-in. and 7-ft. 6-in., respectively. The maximum height under the spindle and above the base is 50-in. The table height is 19-in. Motive power may be furnished by a 3-h.p. constant speed motor or a 3 to 1 variable speed motor as desired.

HYDROGEN GAS FOR CUTTING AND WELDING

While acetylene in combination with oxygen is widely used for welding and cutting, there are certain disadvantages in the process due to the explosive character of the acetylene. In order to eliminate the disadvantages incident to the use of acetylene, the Carbo-Hydrogen Company of America, Pittsburgh, Pa., has developed a gas known as carbo-hydrogen with the view to furnishing an efficient and safe medium for use in cutting and certain classes of welding.

Carbo-hydrogen is a product of the destructive distillation of suitable hydro-carbons and has a general analysis of 85 per cent hydrogen, the balance being light hydro-carbons. It is a fixed gas, permanent under all weather conditions, and does not solidify or leave any residue in the tank. Being a combustible gas and not an explosive, it is easy to use and safer than acetylene. No air or free oxygen is mixed with the gas in the process of manufacture.

Gases having a high B.t.u. value are necessarily slow in combustion and require a longer time to deliver a given amount of heat and a larger expenditure of oxygen than gases having a higher rate of combustion. For this reason, a smaller portion of oxygen is needed for a given amount of work where carbo-hydrogen is used. The gas maintains a very high rate of combustion and ignition and consequently generates an intense heat.

In cutting ferrous metals gases having a high carbon content change the character of the metal at the cut, hardening it so that machining or caulking is exceedingly difficult. It is claimed that metal cut by the carbo-hydrogen process on the other hand retains soft surfaces that can readily be worked, while the absence of slag increases the speed of cutting and produces a smoother surface.

The use of carbo-hydrogen for heavy welding on steel parts is not advocated by the manufacturers, although the process is said to be superior to the oxy-acetylene flame for welding softer metals, such as cast iron, copper, brass and aluminum. Carbo-hydrogen is also used on light gage iron and steel welding and for lead burning.

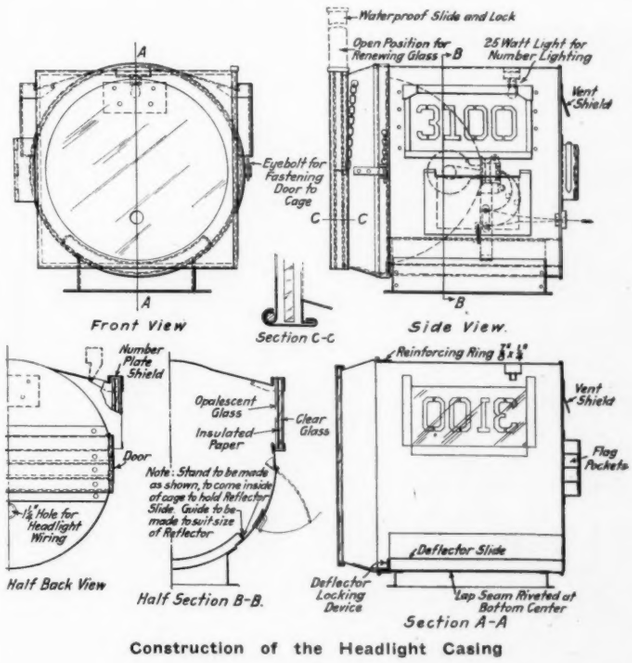
Among the advantages of carbo-hydrogen may be mentioned the absence of dangerous and poisonous gases in the products of combustion which often prove injurious to operators. Being composed largely of pure hydrogen, carbo-hydrogen burns almost entirely to water, while the combustion of acetylene and oxygen produces at least 50 per cent carbon monoxide. Carbo-hydrogen is supplied in drawn steel cylinders compressed to 1800 lb. per sq. in. The working pressure varies from 5 to 10 lb. per sq. in., making it possible to withdraw practically all the gas from the tank.

LUCAS HEADLIGHT AND MARKER LAMPS

A headlight casing having a number of improvements over the older types of casings, and a combination flag holder and electric classification or marker lamp, have been developed by A. N. Lucas, shop superintendent of the locomotive department of the Chicago, Milwaukee & St. Paul shops at Milwaukee.

HEADLIGHT CASING

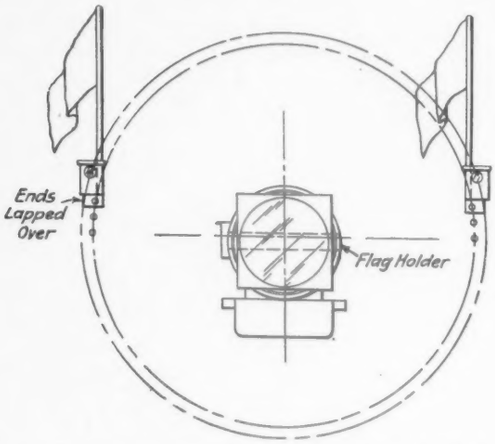
The headlight casing is designed to use an 18-in. square glass instead of the usual 18-in. round glass, thus eliminating much of the breakage experienced in cutting and applying the round glass. The glass can be applied to this headlight without the use of putty or bolts or any cutting to fit, as standard 18-in. square glass is used, or the glass may be applied in two or more pieces.



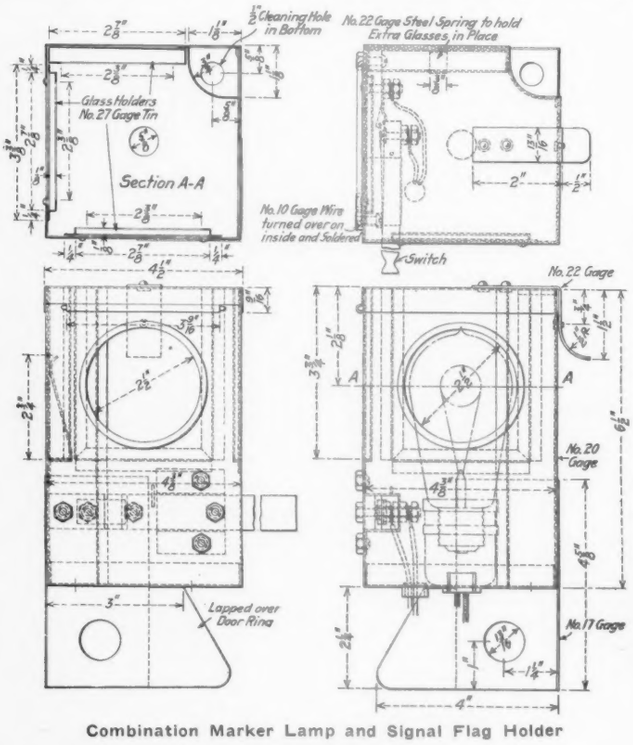
Construction of the Headlight Casing

The body of the casing is made so that the base plate passes through a slot at the bottom of the cage, stiffening it at the proper point. The slide for the reflector and the base plate are in one piece. This avoids double thickness and prevents the rusting of the headlight casing at this point, thereby increasing its life considerably. The exten-

sion for the glass showing the engine number is provided with a cover having a hinge, so that the numbers can readily be changed without the use of thumb screws, which might become rusted and inoperative. The front door is provided with a strong hinge and lock so that it may be fastened securely. On the left side below the engine number, a hinged door gives access to the interior of the case so that adjustment of the reflector or repairs may be made readily. Four pockets on the back of the headlight casing provide a storage place for the signal flags, which are shown in the illustration of the classification lamp.



The Headlight Marker Lamp and Signal Flags Applied to the Front End


Glass Holders No. 27 Gage Tin
Section A-A
No. 10 Gage Wire turned over on inside and Soldered
Switch
No. 22 Gage
No. 20 Gage
No. 17 Gage
Lapped over Door Rina

Combination Marker Lamp and Signal Flag Holder

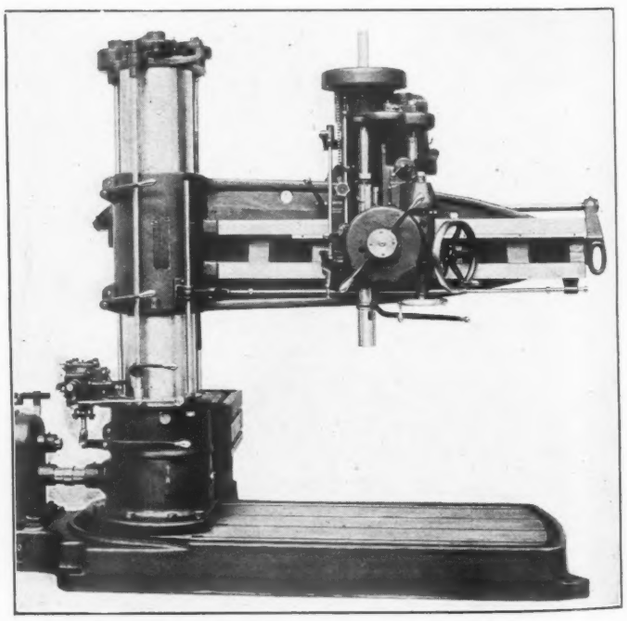
CLASSIFICATION LAMP

A combination flag holder and classification or marker lamp, which has been giving good results on the Chicago, Milwaukee & St. Paul, is shown in the illustration. This lamp is made of heavy galvanized sheet iron and all the joints are spot welded or riveted with eight-ounce rivets. Its construction is clearly shown in the drawing. The socket for the electric light bulb is at the bottom of the lamp and the switch is located at the lamp, making it necessary to go to the lamp in order to turn on the light, thus insuring that the engineman will know if the light is in operation. The lamp contains the usual lens and is provided with a receptacle to hold four extra lenses. After the lamp has been securely bolted to the front end, the part of the lamp flange extending over the front ring is turned down and prevents the lamp from turning in either direction.

A socket for a signal flag is located in one corner of the lamp, making a separate flag holder unnecessary. The flags used in the sockets of these lamps are somewhat smaller than the flags generally used, being 12 in. by 18 in. and the staff 22 in. long. The flags formerly in use were 18 in. by 24 in. and the staff 36 in. long. Due to the size of the flags and the long staff, breakages and losses of flags were frequent because of strong winds, but this smaller flag and shorter staff have eliminated practically all loss from this cause. These flags are of proper size to be inserted in the flag pockets shown in the illustration of the headlight casing, thus locating them in a convenient place and at the same time preventing the soiling or loss of flags which usually takes place when flags are thrown in the locomotive cab because no storage space is provided for them.

COLUMN CLAMPING DEVICE

The column of the Fosdick radial drill illustrated is clamped by a special combination pneumatic and hand clamping device, of which the most noticeable feature is the location of the air cylinder, bringing the pressure directly to the point of clamping. The device will operate equally well on high or low pressures. The clamping is accomplished by an air cushion at each end of the cylinder, formed by additional ports in the valve to insure a compression at the proper termination of each stroke. The valve is operated by mechanical connection to a horizontal shifter bar running along the radial arm. The advantage of this device is that it has no connection with and does not interfere with the movement of the spindle head. In case of failure of the air the pet cocks at either end of the cylinder are opened and the usual method of clamping by hand is used.



Fosdick Radial Drill with Clamping Device

Railway Mechanical Engineer

(Formerly the RAILWAY AGE GAZETTE, MECHANICAL EDITION *with which the* AMERICAN ENGINEER *was incorporated)*

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WE GUARANTEE, that of this issue 12,000 copies were printed; that of these 12,000 copies 11,191 were mailed to regular paid subscribers, 20 were provided for counter and news company sales, 223 were mailed to advertisers, 29 were mailed to employees and correspondents, and 537 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 107,710, an average of 9,792 copies a month.

THE RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. P. C.).

The Italian State Railways are said to have ordered a large number of oil-driven locomotives in Italy and the United States, in order to effect an immediate economy in coal.

The Belgian Minister of Railways, states Modern Transport, has bought from the British government 8,750 freight cars formerly used by the British army, which are still in France.

The British Ministry of Transport, according to a press report, is making arrangements for turning a number of munitions factory buildings into shops for the repairing of locomotives and cars now being returned from France, where they were used during the war.

Railway companies subject to the jurisdiction of the Board of Railway Commissioners for Canada have been granted an extension of time until September 30, 1920, within which to equip freight cars with safety appliances, as required by a recent order of the board.

The contract awarded by the German government to the Krupp Works for the construction of rolling stock, is reported by the United States commercial attache at The Hague, as calling for 2,000 freight cars of 15 tons capacity and 100 locomotives each year. It is said that the contract stipulates that the price must correspond to costs of material and labor and that the factory shall make a profit of only two per cent.

Exports of locomotives in August totaled 69, of a value of $1,539,540. This was considerably more than in July, but not as great as the exports of some of the preceding months. Over half the August total from the standpoint of value were destined for Japanese China. The exports of car wheels and axles in August totaled $1,302,546, nearly one-half of which total was destined for Japan. There were also large shipments to British India and to France.

Frank H. Clark, consulting engineer of New York City, has left the country temporarily, going to Peking to act as technical adviser to the Ministry of Communications of the Republic of China. Mr. Clark recently resigned as general superintendent of motive power of the Baltimore & Ohio and opened offices in New York City to undertake engineering investigations, report upon railway conditions and operations and co-operate in the preparation of plans and specifications for railway equipment and materials as well as to advise export firms, foreign railways and other concerns purchasing materials or equipment from United States manufacturers. He was at one time associated with David L. Barnes, consulting engineer of Chicago for four years, and later entered the service of the Chicago, Burlington & Quincy, where he held

F. H. Clark

RAILROAD CLUB MEETINGS

Club.	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian		Power House Operation	W. J. Harding	W. A. Booth	131 Charron Street, Montreal, Que.
Central	Nov. 13	Annual Dinner		H. D. Vought	95 Liberty Street, New York.
Cincinnati	Nov. 11	Annual Banquet and Entertainment		H. Boutet	101 Carew Building, Cincinnati, Ohio.
New England	Nov. 18	Economy of Stationary Power Plants	C. A. Brandt	W. E. Cade, Jr.	683 Atlantic Avenue, Boston, Mass.
New York	Nov. 21	Annual Electrical Night		H. D. Vought	95 Liberty Street, New York.
Pittsburgh	Nov. 28			J. D. Conway	515 Grandview Ave., Pittsburgh, Pa.
St. Louis	Nov. 14	Fuel Economy and Locomotive Operation	Robert Collett	B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Nov. 17	Treatment of Water for Locomotive Boilers	Wm. M. Barr	J. M. Byrne	916 West 78th Street, Chicago, Ill.

successively the position of chief draftsman, mechanical engineer, superintendent of motive power and general superintendent of motive power. Resigning from that company in 1910, he joined the staff of the Baltimore & Ohio as general superintendent of motive power, a position he held for eight years. Mr. Clark is a member and has served as president of the American Railway Master Mechanics' Association and the Master Car Builders' Association.

Alfred LaMar, assistant director of sales of the war department, who went to Europe early in April to survey European markets, has returned to Washington and resumed his duties in the office of the director of sales. Mr. LaMar has the immediate supervision of sales of surplus war materials made for export, and directs the activities of the machine tool section of the office of the director of sales. While in Europe Mr. LaMar arranged the details of the visit recently made to the United States by a commission from the Construction Metallique which came to this country under the auspices of the Belgian government to inspect government-owned machine tools, with a view to purchasing. Mr. LaMar organized the machine tool section of the office of the director of sales shortly after the establishment of that office by the secretary of war.

MEETINGS AND CONVENTIONS

Master Boiler Makers' Association.—The executive committee of the Master Boiler Makers' Association has announced that the next annual meeting of that association will be held at the Curtis Hotel, Minneapolis, Minn., May 25-28.

Chicago Car Foremen's Association.—At the annual meeting of the Car Foremen's Association of Chicago, held at the Hotel Morrison on October 13, the following officers were elected: President, M. F. Covert, Standard Car Construction Company; first vice-president, James Reed, assistant master car builder, New York Central; second vice-president, E. H. Mattingly, general car foreman, Baltimore & Ohio; treasurer, F. C. Schultz, Chicago Car Interchange Bureau; secretary, Aaron Kline.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railroad Association, Section III.—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

American Railway Tool Foremen's Association.—R. D. Fletcher, Belt Railway, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti. C. & N. W., Room 411, C. & N. W. Station, Chicago.

Car Foremen's Association of Chicago.—Aaron Kline, 841 Lawlor Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary, Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Chief Interchange Car Inspectors' and Car Foremen's Association.—H. J. Smith, D. L. & W., Scranton, Pa.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, C. H. & D., Lima, Ohio.

International Railway Fuel Association.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York.

Master Car and Locomotive Painters' Association of U. S. and Canada. A. P. Dane, B. & M., Reading, Mass.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Railway Storekeepers' Association.—J. P. Murphy, Box C, Collinwood, Ohio.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

PERSONAL MENTION

GENERAL

A. B. Corbett, shop superintendent of the Missouri, Kansas & Texas, at Parsons, Kan., has been appointed assistant mechanical superintendent of the Missouri, Kansas & Texas of Texas, with office at Denison, Tex., succeeding R. W. Burnett.

W. Malthaner, general master mechanic of the Northwest district of the Baltimore & Ohio, Western Lines, with headquarters at Cleveland, Ohio, has been appointed acting superintendent of maintenance of equipment, with headquarters at Cincinnati, Ohio, succeeding the late Matthew J. McCarthy. Mr. Malthaner was born at Salem, N. Y., on August 4, 1874. He entered railroad service as a machinist apprentice on the Delaware & Hudson at Green Island, N. Y., in 1889, and at the end of four years was made a gang foreman in the same shop, serving in this capacity on various classes of work until 1896. He then left railway work, taking employment with the General Electric Company as a machinist, but returned after two years to the Green Island shops of the Delaware & Hudson as foreman of the air brake department. In 1900 he became terminal foreman of the same road at Schenectady, N. Y., and after two years in this capacity was appointed general foreman at Plattsburg, N. Y. In 1914 he was made division master mechanic of the Saratoga & Champlain divisions of the Delaware & Hudson, occupying this position until 1912, when he was transferred to the Susquehanna division. Early in 1915 he accepted the position of shop superintendent of the Baltimore & Ohio at Newark, Ohio, and in 1917 was appointed general master mechanic of the Northwest district. This is the position he held when he was recently appointed acting superintendent maintenance of equipment.

W. Malthaner

F. W. Boardman has been appointed fuel supervisor of the Texas & Pacific, the Trans-Mississippi Terminal Railroad, the Weatherford, Mineral Wells & Northwestern, the Gulf, Texas & Western, the Denison & Pacific Suburban Railroad, and the Fort Worth Belt Railroad, with headquarters at Dallas, Texas, succeeding W. L. McMurray, assigned to other duties.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

J. O. Goodwin, road foreman of engines of the Michigan Central, with office at West Bay City, Mich., has been appointed division master mechanic to succeed J. S. Jennings, at Bay City.

W. G. Johnston, master mechanic of the Newark division of the Baltimore & Ohio, Western Lines, at Newark, Ohio, has been appointed general master mechanic of the

Northwest district, with headquarters at Cleveland, Ohio, succeeding W. Malthaner.

A. M. MESTON has been appointed district road foreman of engines and oil burning inspector of the Southern Pacific, with headquarters at Los Angeles, Cal., succeeding F. W. Corcoran, assigned to other duties.

H. L. MOORE, road foreman of engines of the Southern Pacific at Tucson, Ariz., has been appointed road foreman of engines of the Coast division, Southern Pacific, with headquarters at San Francisco, Cal., succeeding C. H. Holdredge.

FRANKLIN E. COOPER, shop superintendent of the Baltimore & Ohio Western Lines at Newark, Ohio, has been appointed master mechanic with headquarters at Newark, to succeed W. D. Johnson. Mr. Cooper was born on October 22, 1882, at Connellsville, Pa., and was educated in the public schools at McKees Rocks, Pa., and at Pittsburgh High School. His railroad service dates from February 1, 1903, when he took employment with the Pittsburgh & Lake Erie at McKees Rocks as a machinist apprentice, later being employed there as machinist. Afterwards for a time he was material inspector for the New York Central, but subsequently returned to the Pittsburgh & Lake Erie as apprentice instructor at McKees Rocks, and was later assistant machine shop foreman and then machine shop foreman. On April 16, 1916, he accepted a position with the Baltimore & Ohio as general foreman of the Newark shops, being appointed superintendent of shops on February 1, 1917. On August 1, 1919, the positions of master mechanic and superintendent of shops were combined, and Mr. Cooper was appointed to the position with the title of master mechanic, having jurisdiction over the locomotive and car departments of the Newark division.

F. E. Cooper

SHOP AND ENGINEHOUSE

J. C. BREKENFELD has been appointed shop supervisor of the St. Louis-San Francisco, with headquarters at Springfield. Mo., succeeding A. J. Devlin.

JOHN J. DAVIS, general foreman of the machine shops of the Pennsylvania at Philadelphia, Pa., has been transferred to Altoona, succeeding Henry S. Schum, assigned to other duties because of illness.

PURCHASING AND STOREKEEPING

W. W. BLOWNEY has been appointed assistant purchasing agent, in charge of purchases and stores, of the Toledo, St. Louis & Western and the Detroit & Toledo Shore Line, with headquarters at Toledo, Ohio.

G. V. BOOTH, storekeeper of the Detroit, Toledo & Ironton, has been appointed general storekeeper at Jackson, Ohio.

C. B. PORTER has been appointed acting purchasing agent of the Texas & Pacific and allied lines, with office at Dallas, Tex., R. I. Irwin, purchasing agent, having been granted leave of absence.

OBITUARY

EUGENE CHAMBERLAIN, who recently retired as manager of the equipment clearing house of the New York Central lines, died suddenly September 30 at his home in Mt. Vernon, N. Y. Mr. Chamberlain was in his 70th year. He began railroad service in Ohio with the Wabash. Some time after entering the employ of the New York Central he was appointed master car builder of the Western division with headquarters in Buffalo. In 1893 he left railroad service to engage in business, but in 1899 became superintendent of equipment of the Brooklyn Rapid Transit and five years later was called back by the New York Central to the position he held at the time of his retirement. He was a founder and senior past president of the Central Railway Club of Buffalo, past president of the New York Railroad Club and was active in the Master Car Builders' Association and the American Railway Master Mechanics' Association, now known as Section III—Mechanical, American Railroad Association.

E. Chamberlain

MORGAN K. BARNUM, corporate mechanical engineer of the Baltimore & Ohio, died October 26 at Baltimore, Md. Beginning in 1917, Mr. Barnum acted as assistant to the vice-president of the Baltimore & Ohio, giving special attention to the conservation of materials. He graduated from Syracuse University in 1884 with the degree of A.B., and later received the degree of A.M. After graduation he began work in the shops of the New York, Lake Erie & Western, at Susquehanna, Pa. He soon became machinist and mechanical inspector and two years later general foreman at Salamanca, N. Y. In 1889 he was appointed general foreman of the Louisville & Nashville at New Decatur, Ala., and in September of the following year became superintendent of shops of the Atchison, Topeka & Santa Fe at Cheyenne, Wyo. During the years between 1890 and 1904 he served with the Union Pacific, Southern and the Chicago, Rock Island & Pacific. In 1904 he was appointed mechanical expert of the Chicago, Burlington & Quincy. In April, 1910, he became general superintendent of motive power of the Illinois Central and the Yazoo & Mississippi Valley. He became general mechanical inspector of the Baltimore & Ohio in July, 1913, and in September, 1914, superintendent of motive power, the position he held when he was appointed corporate mechanical engineer.

M. K. Barnum

SUPPLY TRADE NOTES

The Southern Wheel Company, St. Louis, Mo., is considering plans for additions to its plant to cost approximately $400,000.

The American Brake Company, St. Louis, Mo., is planning on erecting a four-story machine shop, at an estimated cost of $225,000.

James S. Hearons has become affiliated with the Gustin-Bacon Manufacturing Company, Kansas City, Mo., as railroad representative.

The Bowen Motors Railway Corporation, Terre Haute, Ind., has completed plans for a plant to produce gasoline-propelled passenger cars.

The Chesapeake Iron Works, Baltimore, Md., have opened an office in the Woolworth building, New York, which is in charge of H. L. Mode.

The Chicago Pneumatic Tool Company, Chicago, on October 1, removed its Birmingham office from 801 Brown Marx building to 1925 Fifth avenue, north.

The name of the Schroeder Headlight & Generator Company, Evansville, Ind., was changed to Sunbeam Electric Manufacturing Company on September 27, 1919.

Horace S. Wilkinson, of Syracuse, N. Y., has been elected chairman of the Crucible Steel Company of America, Pittsburgh, Pa., to succeed Herbert Du Puy, resigned.

T. W. Holt, assistant general manager of the Curtain Supply Company, Chicago, has been elected a director and secretary, in place of William S. Estell, resigned.

Louis J. Schneider has been appointed general sales manager of the Clark Tructractor Company, Chicago. Mr. Schneider is a graduate of Stevens Institute of Technology, Hoboken, N. J., and is a member of the Society of Automotive Engineers, as well as the American Society of Mechanical Engineers. He served in the engineering department of the Hyatt Roller Bearing Company during 1911 and in the sales department from 1912 to 1916; during the early part of 1917 he was sales manager of the Jackson Rim Company, Jackson, Mich., and later in the same year he became sales manager of the Harrison Radiator Company, Lockport, N. Y., which position he resigned to take charge of the sales department of the Clark Tructractor Company.

L. J. Schneider

L. A. Muttart, railroad salesman for the Western Electric Company, Inc., Chicago, with headquarters in that city, has been promoted to manager of the Chicago railroad sales department of that company.

C. N. Replogle has resigned as general manager of the Ralston Steel Car Company, Columbus, Ohio, to become general manager of the new plant of the Timken Roller Bearing Company, Canton, Ohio.

R. H. Brown, Jr., of the St. Louis, Mo., office of the Ingersoll-Rand Company, New York, has been appointed manager of the new office of the company in the Sam Houston Life Building, Dallas, Tex.

The Vapor Car Heating Company of Canada, Ltd., with headquarters at Montreal, Que., has taken over the business of the Canadian branch at Montreal of the Vapor Car Heating Company, Inc., of Chicago.

The Vanadium Corporation of America, New York, has bought the property and rights of the American Vanadium Company, and has elected officers as follows: J. Leonard Replogle, president, Merrill G. Baker, vice-president; Lawrence E. Diffenderfer, treasurer, and Edward F. Nickerson, secretary. J. Leonard Replogle was born in Bedford county, Pa., on May 6, 1876, and was educated in the public schools of Johnstown. He entered the employ of the Cambria Steel Company as office boy at the age of 13, and served successively as clerk, shipper, assistant superintendent of the axle department, superintendent of the forge, axle and bolt departments, assistant to the assistant general manager, superintendent of the order department, assistant general manager, assistant to president, and in September, 1912, was elected vice-president and general manager of sales. In February, 1915, he resigned from the Cambria Steel Company to become vice-president and general manager of sales of the American Vanadium Company, and subsequently became president and general manager of sales of the same company. He is also president of the Wharton & Northern Railroad, and chairman of the board of directors of the Wharton Steel Company. Mr. Replogle, during the war, also served as director of steel supplies for the War Industries Board and had conferred upon him recently by the French government the decoration of Chevalier of the Legion of Honor in recognition of the service he rendered for the Allied cause.

J. Leonard Replogle

A. Clark Moore, vice-president of the Safety Car Heating & Lighting Company, Chicago, has resigned to become associated with the Globe Seamless Steel Tube Company, Chicago, with temporary headquarters in that city.

O. A. Phenix, associated with the sales department of the United States Graphite Company, Saginaw, Mich., with office at Birmingham, Ala., has been promoted to advertising manager with office at Chicago, succeeding George A. Cooper.

The Lyon Metallic Manufacturing Company, Aurora, Ill., has opened a New England district sales branch at 161 Devonshire street, Boston, Mass., in charge of J. B. Throckmorton, formerly New York City representative of the company.

The American Car & Foundry Company has purchased two pieces of property adjacent to its plant in Chicago at a consideration of approximately $90,000. One of the properties is 361 ft. by 240 ft. and the other 100 ft. by

240 ft. The company contemplates the building of an addition to the present plant which, together with the rebuilding of the old plant, will cost approximately $2,000,000.

The Rock Island Brake Shoe & Foundry Company, Rock Island, Ill., has been incorporated with $200,000 capital stock to manufacture brake shoes and other railway supplies. The incorporators are Simon Lewis, Hyman Lewis and M. I. Morris.

E. L. Chollman, formerly with the Southern Locomotive Valve Gear Company, has been made vice-president and sales manager of the Paxton-Mitchell Company, Omaha, Neb. Mr. Chollman was born on August 5, 1877, at Omaha, Neb. He entered railway service in 1892 as a machinist apprentice on the Union Pacific at its Omaha shops. From 1897 to 1901 he was machinist on various railroads and from 1901 to 1902 was roundhouse foreman on the Union Pacific, with office at Evanston, Wyo. In 1902, he was appointed assistant general foreman at Cheyenne, Wyo. From 1903 to 1904 he was master mechanic for the La Follette Coal & Iron Railway Company, La Follette, Tenn. In the latter year he was appointed general foreman on the Southern, with office at Alexandria, Va. In 1905 he was appointed general foreman at Danville, Va., and in 1906 was transferred to Greensboro, N. C., which position he held until 1909 when he was appointed superintendent of car shops at Knoxville, Tenn. In July, 1914, he was elected vice-president of the Southern Locomotive Valve Gear Company, Knoxville, Tenn., a position which he held until his recent election as vice-president and also manager of the Paxton-Mitchell Company.

E. L. Chollman

C. E. Hutchison, formerly district representative at St. Louis, Mo., of the La Belle Iron Works, Steubenville, Ohio, has resigned to become associated with the Youngstown Sheet & Tube Company, Youngstown, Ohio, with headquarters at Cleveland, Ohio.

The Armstrong Brothers Tool Company, Chicago, is erecting an addition to the drop forge department, a new building for the hardening and heat treating department and a new reinforced concrete building for the general office, finished stock and shipping department.

G. E. Anderson, formerly assistant to the vice-president of the American Locomotive Company, has been appointed assistant eastern sales manager of the Duff Manufacturing Company, Pittsburgh, Pa., with headquarters at the eastern sales offices, 50 Church street, New York.

The Pollak Steel Company, Cincinnati, Ohio, has appointed the C. A. S. Engineering Company, 790 Woodward avenue, Detroit, Mich., as its representative in the Detroit district, which embraces Michigan and northern Ohio, including the cities of Toledo, Elyria and Cleveland.

Charles H. Small and George F. Shade have established an office in the Monadnock building, San Francisco, Cal., as agents for the Sargent Company, Chicago, auxiliary locomotive device manufacturers. They will also act as agents for other manufacturers of railway specialties.

George R. Woods has resigned from the Allied Machinery Company of America, New York, to become manager of the New York office of R. S. Stokvis & Zonen, Ltd., Rotterdam, Holland. Mr. Woods has been in Europe studying industrial and economical conditions and returns to New York to take up his new duties.

H. V. McKedy, assistant to the vice-president in charge of sales of the American Locomotive Company, New York, has severed his connection with that company. He has been appointed eastern representative of the Glidden Company, Cleveland, Ohio, with headquarters at 636 West Thirty-fourth street, New York.

J. H. Mitchell, who has for some time been manager of sales of the western district for the Pressed Steel Car Company and the Western Steel Car & Foundry Company, with headquarters in Chicago, left recently for Havana, Cuba, to assume the position of executive vice-president of the American Steel Company of Cuba.

Louis W. Ulmer, has been appointed eastern railway sales representative of the Detroit White Lead Works, with office in Philadelphia, Pa. Mr. Ulmer has recently been released from his duties in the United States Marine Corps and was connected with the Detroit White Lead Works before he entered the military service.

C. W. Cross, special railroad representative of the Chicago Pneumatic Tool Company, with office at Chicago, has been appointed manager of western railroad sales with the same headquarters, succeeding L. C. Sprague, who has resigned to become general mechanical inspector of the Galena-Signal Oil Company, with office at Minneapolis, Minn.

Major C. G. Carothers who served in the U. S. Army as captain and major from September, 1917, to September, 1919, has been appointed Chicago railroad representative of the B. F. Goodrich Rubber Company, with headquarters at Akron, Ohio, succeeding F. O. Slutz, promoted. Major Carothers was born on August 31, 1881, at Mattoon, Ill., and was educated in the grade and high schools of his native town. He served an apprenticeship as machinist at Mattoon on the Cleveland, Cincinnati, Chicago & St. Louis, and then worked for a number of western railroads. He subsequently attended Purdue University, Lafayette, Ind., and was graduated as a railway mechanical engineer in 1912. From August of that year to August, 1914, he was mechanical engineer with the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio. He then served to September, 1917, as senior mechanical engineer with the Interstate Commerce Commission, Division of Valuation, Southern District, with headquarters at Chattanooga, Tenn. In July, 1917, he received a commission as captain in the Engineers Reserve Corps and was called to active service the following September to attend the Second Engineer Officers' Training Camp, American University, Washington, D. C. He subsequently was attached to the 301st Engineers of the 76th Division at Camp Devens, Ayer, Mass., and in January, 1918, was sent to France to report to the general superintendent of motive power, Colonel H. H. Maxfield of the Railway Trans-

Maj. C. G. Carothers

portation Corps. He subsequently served in the railroad yard at Is-sur-Tille as master mechanic and built a shop there, also one at Villa-le-Sex, the advance section ammunition depot. He later served as superintendent of motive power of the 13th Grand Division, with headquarters at Is-sur-Tille.

Fred J. Holden, who has represented B. M. Jones & Co., Inc., New York, for a number of years, has been appointed manager of the railway department. Austin Savage, formerly of Samuel Osborn & Co., Ltd., Sheffield, England, is now located in New York and has been elected secretary and treasurer of B. M. Jones & Co., Inc.

Lawrence A. Rowe, mechanical inspector on the Atchison, Topeka & Santa Fe, with headquarters at Chicago, has been appointed general manager of the Universal Packing & Service Company, with office at Chicago. This company has been organized to manufacture and sell spring journal box packing and in addition will maintain a service department.

The Detroit Star Grinding Wheel Company has been formed by merging the business of the Detroit Grinding Wheel Company and the Star Corundum Wheel Company, both of Detroit, Mich. The officers of the new company are John R. Kempf, president; J. T. Wing, vice-president; F. H. Whelden, secretary and treasurer. Edward N. Dodge, formerly with the Norton Company, Worcester, Mass., has been appointed general sales manager. The company's plant and offices will be at 241-61 Cavalry avenue, Detroit, Mich.

H. W. Ross has been elected vice-president of Templeton, Kenly & Co., Ltd., Chicago, manufacturers of Simplex jacks. In 1916 Mr. Ross was designated as engineer in charge of installing a bureau of standards for the Quartermaster Corps, U. S. A., for the purpose of testing and selecting various motor machine shop tools and accessory equipment for the United States government. In 1917 he was called to Washington to purchase machinery, tools and auto accessories for use of the Motor Transport Corps in France, on August 1, 1917, receiving his commission as captain, later being promoted to major. He went overseas, where he was connected with the Motor Transport Corps in an engineering and purchasing capacity and was later sent to Spain and Portugal in connection with the general purchasing board. After the close of hostilities Major Ross was selected as officer in charge of sales of Motor Transport Corps equipment in connection with the United States Liquidation Commission, and he had charge of the appraisal and selling of the vast quantities of motor cars, trucks, motor cycles and machinery that the government had accumulated in France. Major Ross returned to the United States on September 15, and at his request was mustered out of the service soon thereafter. His new work covers the general sales management of Simplex jacks, and he will give particular attention to the Simplex pole pulling and pole straightening and special emergency jacks used by steam and electric railways and other public utility companies.

H. W. Ross

CATALOGUES

Forging.—A series of pamphlets entitled National Forging Machine Talks is being distributed by the National Machinery Company, Tiffin, Ohio. No. 36 describes a method of forming the eyes on brake hangers.

Curtain Fixtures.—Bulletin F-1, published by the Curtain Supply Company, New York, describes and illustrates the action of the ring curtain fixtures developed by this company and contains sketches showing standard types of open and enclosed grooves to aid in selecting the proper style of ring fixture.

Electric Arc Welding.—The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued Circular No. 7149, covering the process of electric arc welding and the necessary apparatus required. A comparison is made of the different processes of welding and the advantages of electric arc welding are pointed out.

Care of Electric Hoists.—Facts for Operators of Electric Hoists is the title of a four-page pamphlet published by the Electric Hoist Manufacturers' Association, New York, for the guidance of electric hoist operators. It deals with such matters as connections, lubrication, and the care of the motor, controllers and ropes.

Asbestos.—The Magnesia Association of America, Philadelphia, Pa., is now publishing a monthly booklet which is devoted to the interests of the asbestos and magnesia industries. The magazine is known as "Asbestos" and contains information regarding market conditions and prices, and articles on subjects of special interest to users and manufacturers of asbestos and allied products.

Steel Treating. — Detailed instructions for treating Colonial tool steel and tools have been compiled as the result of experience, by the Colonial Steel Company, Pittsburgh, Pa., and published in a booklet entitled The Colonial Tool Steel Treating Book. In addition to the directions for hardening and treating, the book contains a complete list of tools with the grades of Colonial steel best adapted for their use, with a separate list of railroad tools.

Feedwater Heater.—Bulletin 5 of the Locomotive Feed Water Heater Company, New York, is a complete treatise on the application and operation of the Type *E* locomotive feedwater heater developed by this company. A colored chart shows how the heater performs its functions and is arranged to show in a graphical manner just where all of the heat that comes from the burning coal on the grates of the locomotive is distributed and its amount at various points throughout the route between the fuel bed and the top of the stack. A sectional drawing shows the arrangement of the equipment on a locomotive, with all pipe connections.

Welding Locomotive Fireboxes.—The Air Reduction Sales Company, New York, has prepared and published a 40-page booklet, No. 4, describing the Airco process of oxy-acetylene welding as applied to locomotive firebox welding instead of riveting. The booklet is designed to help the operator by showing him the proper methods to follow when welding a firebox. It describes the operations necessary for full and semi-welded side sheets, cracks in side sheets, full welded door and flue sheets, patches on fireboxes and flue sheets, patches on mudring, welding of door collars and door holes, building up worn edges of fireboxes, etc. The different operations are very clearly illustrated by full page drawings.